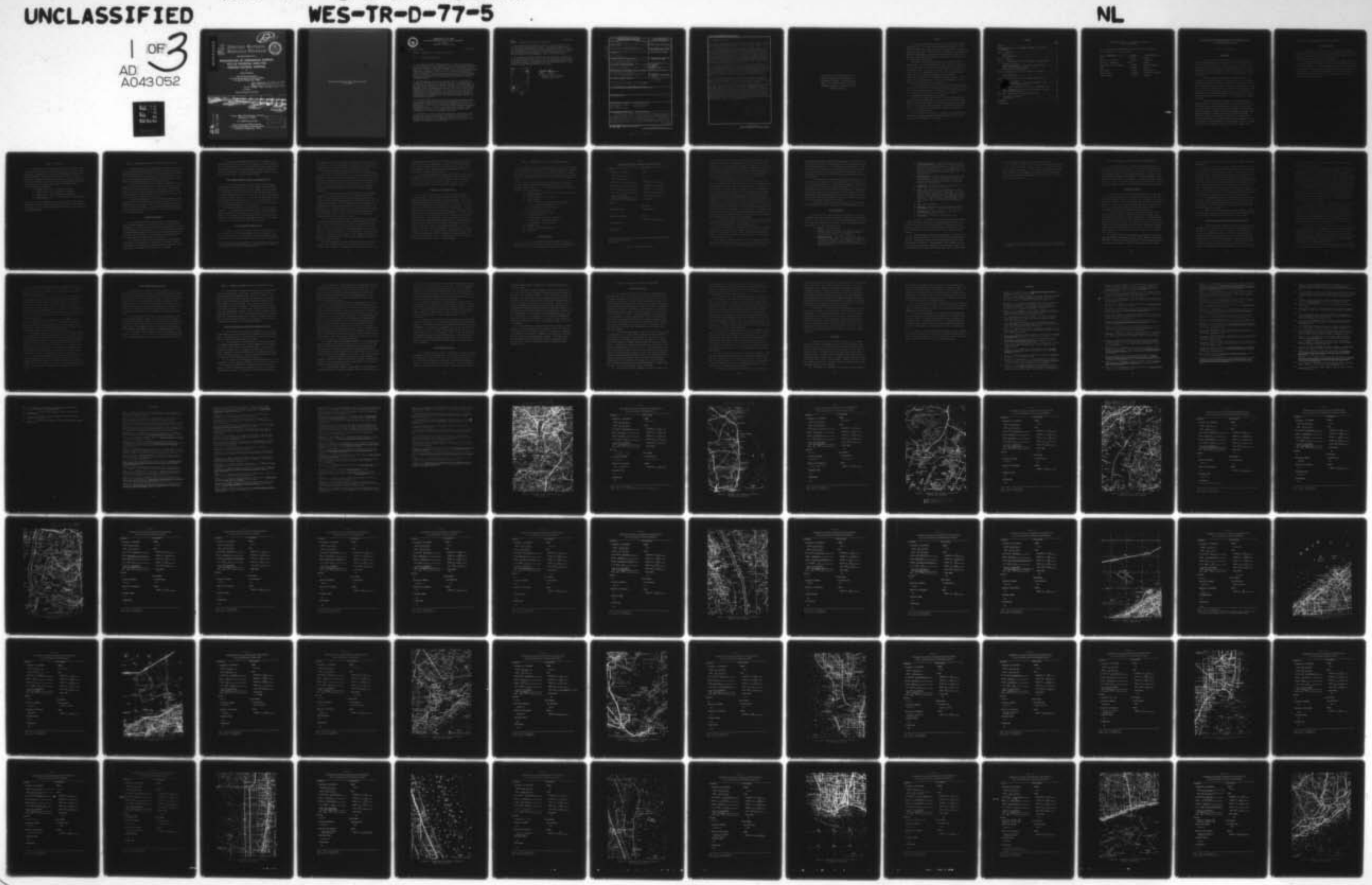
AD-A043 052 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 13/2
INVESTIGATION OF SUBAQUEOUS BORROW PITS AS POTENTIAL SITES FOR --ETC(U)
MAY 77 J D BROUGHTON

UNCLASSIFIED WES-TR-D-77-5 NL

1 OF 3
AD
A043052



12 B.S.

DREDGED MATERIAL RESEARCH PROGRAM

TECHNICAL REPORT D-77-5

INVESTIGATION OF SUBAQUEOUS BORROW PITS AS POTENTIAL SITES FOR DREDGED MATERIAL DISPOSAL

by

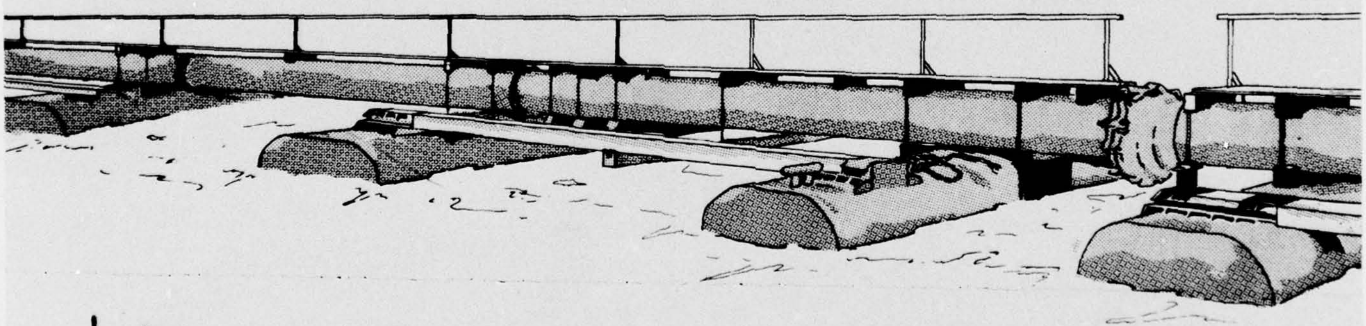
Jerald D. Broughton

Soils and Pavements Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

May 1977

Final Report

Approved For Public Release; Distribution Unlimited



Prepared for Office, Chief of Engineers, U. S. Army
Washington, D. C. 20314

Under DMRP Work Unit 3A01

Monitored by Environmental Effects Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
P. O. BOX 631
VICKSBURG, MISSISSIPPI 39180

IN REPLY REFER TO: WESYV

31 May 1977

SUBJECT: Transmittal of Technical Report D-77-5

TO: All Report Recipients

1. The technical report transmitted herewith represents the results of one of two research efforts completed as part of Task 3A (Aquatic Disposal Concepts Development), which was originally part of the Productive Uses Project of the Corps of Engineers' Dredged Material Research Program (DMRP). Task 3A was transferred in July 1975 to the Environmental Impacts and Criteria Development Project, which is concerned with the environmental effects of open-water disposal of dredged material, including the spatial and temporal distribution of dredged material discharged into various hydrologic regimes.

2. The research was conducted (as Work Unit 3A01) to investigate the geographical distribution and state-of-knowledge of subaqueous borrow pits and natural depressions. Specific objectives were to inventory and describe existing subaqueous pits and to evaluate existing and potential subaqueous sites near dredging projects that could become semiconfining depositories for dredged material. The rationale for this and several related work units assumes there may be instances where restriction of the dispersion and resuspension of material through partial natural confinement would be desirable from either chemical, physical, and/or biological impact viewpoints.

3. The investigation reported herein identified those subaqueous borrow pits, holes, or depressions where baseline determination or other research had been undertaken and briefly described the extent of the investigations. There were few comprehensive studies specifically involved with subaqueous pits. Primarily, the research data available address depressions resulting from or associated with shell dredging, beach nourishment, and construction aggregate operations.

4. An inventory was made of all known borrow pits, depressions, holes, canyons, and trenches and included the location, historical data, and any available descriptive data about each location. Each site is described, accompanied by a standard data form and a portion of a navigational chart showing the site location.

WESYV 31 May 1977

SUBJECT: Transmittal of Technical Report D-77-5

5. The investigation concluded that there is a good potential for the creation of more subaqueous borrow pits. The primary stimulus will be the increasing demand for more construction aggregate and beach nourishment requirements. The inventory data presented can be used as a planning tool for future disposal operations in those areas where a site is not readily available but the dredging is close to one of these pits.

6. The information and data published in this report are contributions to the further understanding of the use of aquatic systems as a depository for dredged material. It is expected that the inventory employed in this study and the resultant evaluation will be of significant value to those persons concerned with CE regulatory activities.

ACCESSION for

NTIS White Section ☒

DDC Buff Section ☐

UNANNOUNCED ☐

JUSTIFICATION ....

BY ....

DISTRIBUTION/AVAILABILITY CODES

Dist.	AVAIL. and/or SPECIAL	
A	23	

John L. Cannon

JOHN L. CANNON
Colonel, Corps of Engineers
Commander and Director

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Technical Report D-77-5	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) INVESTIGATION OF SUBAQUEOUS BORROW PITS AS POTENTIAL SITES FOR DREDGED MATERIAL DISPOSAL.		(9) 5. TYPE OF REPORT & PERIOD COVERED Final report. Jan-Oct 74, 6. ~~PERFORMING ORG.~~ REPORT NUMBER
7. AUTHOR(s) (10) Jerald D. Broughton		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U. S. Army Engineer Waterways Experiment Station Soils and Pavements Laboratory P. O. Box 631, Vicksburg, Miss. 39180		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Task 1A, Work Unit 3A01
11. CONTROLLING OFFICE NAME AND ADDRESS Office, Chief of Engineers, U. S. Army Washington, D. C. 20314	(11)	12. REPORT DATE May 1977 13. NUMBER OF PAGES 190
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Environmental Effects Laboratory U. S. Army Engineer Waterways Experiment Station P. O. Box 631, Vicksburg, Miss. 39180		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

(12) 196p.

Approved for public release; distribution unlimited.

(14) WES-TR-D-77-5

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dredged material disposal
Shell dredging
Sand and gravel dredging
Subaqueous depressions
Submarine canyons

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The disposition of dredged material has become a problem of such proportions that all potential solutions must be explored. ~~The study described in this report~~ (The present study) was conducted to survey existing knowledge of, inventory, describe, and evaluate the potential for using subaqueous pits, holes, or depressions as dredged material disposal sites. The scope of the study was limited to an ~~investigation of~~ (investigating) the estuaries, bays, rivers, and continental shelf areas of the

(Continued) (on p. 1473A)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

038 100

4B

20. ABSTRACT (Continued). (fr p 1473A)

Atlantic, Gulf, Pacific, and Great Lakes coasts of the United States. Included were all subaqueous depressions whether caused by dredging or extraction activities or by natural erosional events. The author concludes that

Files were examined at the U. S. Army Engineer Waterways Experiment Station (WES), selected Corps of Engineers (CE) District offices, and several university-university research organization complexes; and personal contacts were made with other CE Districts, universities, dredging firms, and individuals. These surveys revealed that little research has been accomplished on the effects of pits, holes, or depressions on the aquatic environment. However, the degradation of bays, estuaries, and shelf areas; the importance of these locales to the survival and growth of numerous aquatic species; and increasing public awareness in each of these areas will probably result in an increase in the amount, scope, and detail of such research.

A subaqueous site inventory was accomplished through a review of WES files; personal contacts with CE Districts and other applicable Federal, State, and private agencies; and the use of coastal topographic quads, Coast and Geodetic survey charts, and special studies. This inventory resulted in the location of approximately 125 former, existing, or potential subaqueous pits, holes, or natural depressions. The data collected for each of these sites were recorded on a specially designed form and compiled along with site location maps.

The site data were examined with reference to pertinent literature to obtain qualitative descriptions of the sites. Descriptions of trenches and canyons, beach replenishment or construction aggregate sites, and shell dredging sites were derived in terms of extreme values and average conditions.

The potential for having or creating man-made subaqueous (disposal) sites will depend upon demand and supply of the products excavated. ~~The~~ demand for beach replenishment material will probably increase as will ~~the~~ demands for construction aggregate in the vicinity of large coastal metropolitan areas and shell as a source of aggregate or feed supplement. Adequate supplies for beach replenishment and construction aggregate are presently known or can be reasonably hypothesized, with economic constraints being the only hindrance to widespread usage. Conversely, shell supplies are limited, dredging areas are being curtailed, and the resulting pits fill rapidly. There is little potential, therefore, for shell dredging to leave ~~large~~, extensive pits.

(Thus,)

1473B

THE CONTENTS OF THIS REPORT ARE NOT TO BE USED FOR ADVERTISING, PUBLICATION, OR PROMOTIONAL PURPOSES. CITATION OF TRADE NAMES DOES NOT CONSTITUTE AN OFFICIAL ENDORSEMENT OR APPROVAL OF THE USE OF SUCH COMMERCIAL PRODUCTS.

PREFACE

This study was conducted by personnel of the Soils and Pavements Laboratory (S&PL), U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi, for the Environmental Effects Laboratory (EEL), WES, as a part of the Office, Chief of Engineers, Dredged Material Research Program Aquatic Disposal Field Investigations, Task 1A, Work Unit 3A01, "Investigation of Subaqueous Borrow Pits as Potential Sites for Dredged Material Disposal."

The conduct of this study extended from January 1974 through October 1974. The work was performed by Messrs. William L. Murphy and Jerald D. Broughton of the Engineering Geology and Rock Mechanics Division (EGRMD), S&PL. The study was conducted under the direct supervision of Mr. John H. Shamburger, Chief, Terrestrial Sciences Branch, EGRMD, and under the general supervision of Mr. William B. Steinriede, Jr., Acting Chief, Engineering Geology Division; Mr. Don C. Banks, Chief, EGRMD; and Messrs. James P. Sale and Richard G. Ahlvin, Chief and Assistant Chief, respectively, S&PL.

Primary responsibility for the conduct of the study was assigned to Mr. Broughton with both investigators pursuing all phases of the work. Mr. Murphy was responsible for the completion of the data tables and site location maps. The report was written by Mr. Broughton. Mr. Shamburger furnished technical assistance.

The Contract Manager was Mr. Barry W. Holliday, Environmental Impacts and Criteria Development Project, EEL. The study was conducted under the direct supervision of Dr. Roger Saucier, Special Assistant, and Dr. Robert M. Engler, Project Manager, Environmental Impacts and Criteria Development Project, and under the general supervision of Dr. John Harrison, Chief, EEL.

COL G. H. Hilt, CE, and COL J. L. Cannon, CE, were Directors of WES during the study and preparation and publication of the report. Technical Director was Mr. F. R. Brown.

CONTENTS

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI)
UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
feet	0.3048	metres
miles (U. S. statute)	1.609344	kilometres
miles (U. S. nautical)	1852.0	metres
square miles (U. S. statute)	2.589988	square kilometres
acres	0.40468	hectares
cubic yards	0.764555	cubic metres
feet per mile	0.1893939	metres per kilometre
degrees (angle)	0.01745329	radians

INVESTIGATION OF SUBAQUEOUS BORROW PITS AS POTENTIAL SITES FOR DREDGED MATERIAL DISPOSAL

PART I: INTRODUCTION

Background

1. The disposition of dredged material has become a problem of paramount importance that has resulted from at least three distinct factors. One, public awareness, is primarily qualitative in nature but nevertheless real. The second, increased quantity, is due to the degree and magnitude of port development and related activities. The third, environmental impact, represents the most serious problem with respect to pollution.

2. The increased public awareness is a simple result of the evolvement of an active community of environmentalists. All phases of dredging and disposition have been recognized as potentially harmful to nature's processes, and the numbers of concerned citizens have dictated that a conservative tack be employed for most dredging programs. Dredging activities have always been conspicuous; but as more people have become aware of the potential dangers, attention has focused on high-density dredging areas (harbors, bays, etc.) and hence on the dredging activities.

3. The quantity of material dredged is increasing by ever-expanding amounts. Basically, there are two reasons for this increase. First, port facilities are expanding both vertically and laterally. Vessel drafts are increasing, necessitating channel and berth enlargement and deepening. As harbor traffic has increased and shippers have expanded, additional channels and berths have been necessitated. In addition to expanding facilities, new facilities to expand trade or lessen transportation cost usually require extensive dredging. All of these activities are contributing to the increasing quantity of dredged material and the attendant problems of disposal in a manner that is

conducive to maintaining minimal levels of pollution.

Purpose and Scope

4. The purpose of this study was to inventory, survey existing knowledge of, describe, and evaluate existing and potential sites designated as subaqueous pits, holes, or depressions near dredging projects that may become a depository for dredged material.

5. This study was limited to estuaries, bays, rivers, and continental shelf areas of the Atlantic, Gulf, Pacific, and Great Lakes coasts of the United States. It included subaqueous pits, holes, or depressions in these water bodies that were formed through natural processes or man-made extraction of coarse-grained material for construction or beach replenishment, material for nearshore or dockside fill, or shells for aggregate or cement manufacture.

PART II: APPROACH

6. The facets of this study, while separable into several convenient subtasks for discussion or reporting purposes, could not be readily delineated for sequential or concurrent accomplishment by several independent researchers. Therefore, two investigators were to consult appropriate information sources and make personal visits to identify and locate significant present borrow pit areas and areas where future pits may be developed. The study plan included the following areas of interest and reporting subtasks.

- a. Subaqueous pit, hole, or depression research.
- b. Subaqueous pit, hole, or depression inventory.
- c. Subaqueous pit, hole, or depression description.
- d. Subaqueous pits, holes, or depressions for future development of sites.

These items were all interrelated; while any one of the four was being emphasized, the other three were still being considered. These interrelationships were, on occasion, separable but for the most part interwoven in any data gathered.

PART III: SUBAQUEOUS PIT, HOLE, OR DEPRESSION RESEARCH SURVEY

7. Subaqueous disposal of dredged material would assist in alleviating the problems associated with onshore or nearshore deposition. Primary advantages are the reduction of land areas required and elimination of the destruction of the nearshore or marsh environments. The deposition of materials in nonproductive or low-productive areas of the seabed should cause few detrimental environmental effects.

8. A survey of research directed toward environmental effects of subaqueous pits, holes, or depressions, hereafter referred to as subaqueous sites, was the starting point for this study. The research would furnish input for the remaining three subtasks because it would provide locations of subaqueous sites, a description of the sites, and areas in which future sites could be located.

9. Research on subaqueous sites has generally emphasized three distinct types, with a minimum overlap between the three. These are the subaqueous natural trenches or canyons, sites remaining after sand removal for beach replenishment or coarse-grained construction material, and sites remaining after shell dredging. Each of these are discussed in the following sections.

Trenches and Canyons

10. The works of several researchers who have investigated the numerous canyons heading on the continental shelf are listed in the Bibliography. One of the more recent efforts that furnishes an overview of this research is by Shepard and Dill.[1] Their work locates and briefly describes submarine canyons off both the eastern and western shores of the United States and devotes a small section to the gullies south of the Mississippi River Delta in the Gulf of Mexico.

11. Research on the west coast has been more actively pursued, probably due to the proximity of the canyons to the coast. Some of these canyons reach nearly to the shore and have been excellent field laboratories for studies of the activities in the canyon.

12. The east coast canyons head on the outer continental shelf some 60 miles* from the coast and have received less detailed attention. The most well-known of these is the Hudson Canyon, which, along with the Hudson Channel across the Continental Shelf, connects the Hudson River with the oceanic deeps. Numerous other canyons exist from Cape Lookout, North Carolina, to Nova Scotia as shown by Uchupi.[2]

Beach Replenishment or Construction Aggregate Sites

13. The Corps of Engineers and other private and governmental agencies have been very active in the replenishment of eroded beaches. Unfortunately, the borrow areas are usually simply a necessary adjunct to the operations, and little research has been directed toward them. The primary concern of the operations has been to locate the borrow area a sufficient distance from shore to ensure that the equilibrium processes do not rapidly carry the beach material back to the borrow area. In isolated cases, this process has been monitored and profiles developed, but no systematic research has been accomplished.

14. Murawski's effort is one of the better documented studies available.[3] His research on holes dredged in New Jersey estuaries was directed toward their use by finfish. He recorded locations, sizes, depths, and water quality for 38 subaqueous sites that had been used as a source of construction material and beach restoration. These ranged in area from 1 to 75 acres and in depth from 9 to 65 ft.

Shell Dredging Subaqueous Sites

15. Interest in the shell dredging sites has been spurred by the recent necessity of detailed environmental impact statements in order for a dredging contractor to obtain new or continuing dredging permits. The primary concern of these studies has been to ascertain the effect of

---

* A table of factors for converting U. S. customary units of measurement to metric (SI) units is found on page 4.

the dredging process on the subaqueous environment rather than the long-term effects of the holes remaining. Some studies have touched on the long-term aspect and are included in the Bibliography in addition to the following general conclusions reached by specific investigators.

16. Studies by Masch and Espey[4] on the effect of shell dredging in Galveston Bay focused on former sites serving as interceptors of sediment generated during the shell dredging process. They state that previous data concerning the effects on shellfish and finfish resources are both inconclusive and inconsistent when compared with one another. Although not stated, this conclusion probably applies to the sediment generated during the actual process and not to the holes remaining afterward.

17. The Final Environmental Impact Statement[5] on shell dredging in San Antonio Bay, Texas, indicates that the dredged trenches fill rapidly. The filling process is more pronounced during the first 4 to 6 years, and the bottom animal populations in dredged trenches older than 4 years have recovered to at least 80 percent of the population of the undredged flats, although predredging levels may not be attained. The nekton appear to use the trenches as favored habitat during the December-February period. Detailed temperature-salinity-turbidity-population cause-effect data are not available, and the need is stressed for numerous samples before a pattern can emerge.

18. The Final Environmental Impact Statement[6] for shell dredging in Mobile Bay, Alabama, mentions a 2-year period for bottom leveling but also states that most bottom contour changes are detectable for many years. Similar to those in other studies, these pits are used by finfish during the colder months, but low oxygen concentrations during the summer months are not conducive to a finfish habitat. Additional points are made concerning the low suitability of the low-density dredged pit sediments as shellfish habitat. This problem is usually remedied over an extended period of time.

19. May[7] determined that shell dredging pits have little effect on Mobile Bay. The pits usually fill in 1 to 12 months, and little evidence of their existence is apparent after this period of time. The

dry-weight densities obtained in the filled trenches and on nondredged areas have shown little difference. Another of his studies[8] substantiates extensive oxygen depletion in the bay during the summer months but attributes this to natural phenomena perhaps aided by hindered circulation due to Mobile Channel dredging.

20. Preliminary examinations by Gustafson[9] have indicated a habitat preference by striped bass for dredged pits in the San Francisco Bay, California. These pits also contain an abundant growth of seaweed, which serves as habitat for the native oyster. Several of the pits exist in the area and Gustafson has proposed detailed studies.

Research on Multiorigin Sites

21. Polis[10] has performed a study that documented numerous pits of varying origin. This investigation includes results of other researchers and should furnish a basis for future research. This report reviews the knowledge of environmental effects of borrow pits in estuarine waters with emphasis on the applicability to Maryland. The study was based on literature surveys and personal communications. The work divides pits into categories of canals or bottom cuts with further divisions relating to environmental and channel connections. Two studies reviewed in Polis' work, one relating to shell dredging by Harper and the other relating to beach nourishment reported by the Gulf Coastal Fisheries Center, are applicable to the present study. A study conducted by the Gulf Coastal Fisheries Center centered on a borrow pit from which sand was dredged for Treasure Island beach nourishment. The pit is parallel to the shore and is approximately 1500 ft offshore. Physical dimensions are given, and sediment samples and probings indicate a 3-ft filling between 1969 and 1972 with extremely soft unconsolidated sediment with a high organic content. Several other studies are relevant to the present task and are listed in the Bibliography.

PART IV: SUBAQUEOUS PIT, HOLE, OR DEPRESSION INVENTORY

22. The first step of the inventory was to list the desired information and determine the probability of obtaining these data. A comparison of these factors resulted in the data format presented in Figure 1. The location data, the historical data, and the descriptive data furnish a basis for a qualitative description of the various sites or groups of sites.

23. Next, the potential sources of data had to be identified. This was usually a cumulative and continuing process with one source leading to another and so on. The following sources were initially determined to be most applicable.

- a. Topographic maps that include the coastline and adjoining subaqueous terrain.
- b. Coast and Geodetic (C & G) charts.
- c. Federal agencies.
    - (1) U. S. Army Corps of Engineers (CE) Districts
    - (2) Coastal Engineering Research Center
    - (3) Environmental Protection Agency
    - (4) U. S. Geological Survey
- d. State agencies (variously named)
    - (1) Fish and Wildlife
    - (2) Environmental Protection Department
    - (3) Coastal Zone Coordinating Council
    - (4) Department of Marine Resources
- e. Dredging firms.
- f. Universities (primarily Sea Grant).
- g. Literature.

Data Collection

24. The U. S. Army Engineer Waterways Experiment Station (WES) maintains files of Coast and Geodetic charts as well as topographic maps. These files were used and supplemented by more recent editions. The

Table

Subaqueous Pit, Hole, or Depression Characteristics

Location	Description
Geographic Coordinates	Shape
North ____________	
West ____________	Size
CE District ____________	Diameter, m ____________
State ____________	Length, m ____________
County ____________	Width, m ____________
C & G Chart ____________	Depth, m ____________
1:250,000 Topographic Map ____________	Area, km^2 ____________
Fig. _____ Site ____________	Bank Angle
History	
	Environment
Excavation Method	Bed Materials
Material Utilization	Water
	Depth, m ____________
Available Data	
Alterations	

Note: NA = not available.
Data Source:

Figure 1. Data collection form

best available topographic maps, considering the area involved and the information required, were determined to be the 1:250,000 series published by the U. S. Army Topographic Command. These maps are of a scale permitting a manageable number to encompass the continental coast and have subaqueous contours that define the larger natural depressions. The Coast and Geodetic charts are of various scales, but regardless of the scale they usually show the same depressions. The 1:40,000- and 1:80,000-scale maps were useful during the inventory.

25. The Federal agencies, CE Districts, etc., were first contacted by telephone, and follow-up personal visits were made when it was decided that such a visit could provide useful data. The coastal CE Districts were the major sources of information. All the dredging data in the CE files were not readily extractable because dredging permits are usually filed with no allowances made for purpose or type. This usually necessitated a cursory examination of the files with emphasis placed on CE District personnel's awareness of dredging activities contributing to pits or holes. This was not a major omission because the dredging activities creating pits are usually limited to fill operations, construction material extraction, or beach nourishment; and these activities would generally be remembered by someone in the responsible office. Also, two or more functional Divisions (Environmental, Operations, etc.) of the Districts are usually involved in these activities, thus enhancing the probability that they would be remembered.

26. The Coastal Engineering Research Center is active in the beach nourishment programs, and many of the subaqueous sites located were the result of personal knowledge or their published reports.

27. The State agencies contacted were aware of most of the dredging activities conducted in their boundaries, but their files did not contain all data required by this study. However, the information received from these agencies permitted additional data to be retrieved from the CE District files.

28. Dredging contractor files were also too incomplete for the purposes of this study and usually required use of the CE District files. The CE Districts maintained the permit files for the activities and

usually had the subsequent data verifying adherence to the permit. The shell dredging contractors furnished more data then the construction material dredging contractors. This difference was due primarily to the shell being located in bays or estuaries where the pits have a tendency to remain open, while most construction material contractors work in streams and rivers where the most profitable locations depend upon rapid replenishment.

29. The universities contacted did not have as much data as the CE Districts, but they usually had a ready knowledge of how or where to obtain little-known information. The university community is fairly close-knit, and their investigators usually could furnish a list of recent investigators and their reports related to this study. All investigators contacted were anxious to contribute and even more anxious to learn of anything that might have been unknown to them. The university or staff investigators furnished bibliographies that were used heavily in preparing the bibliography accompanying this report.

30. Literature sources used within the time frame of the study were extremely beneficial in locating and describing subaqueous sites.

Data Presentation

31. The sites are located and numbered on portions of 1:250,000 topographic maps, and the data collected are tabulated on designed forms (Figure 1). The entries used for the tables were standardized to facilitate comparisons between areas and sites. These standardizations and/or explanations for terms are presented below.

a. Location: Self-explanatory.

b. History: Date(s) excavated. Any work not known to have been accomplished is entered as "proposed." Natural depressions are entered as "not available."

c. Excavation method: "Mechanical," "hydraulic," and "natural" are terms used. "Mechanical" covers draglines and clamshell or ladder dredges; "hydraulic" covers suction dredges, whether stationary or trailing; and "natural" is entered for those depressions formed through natural processes.

d. Material utilization: "Coastal replenishment," "fill," and "aggregate" are the terms used. "Coastal replenishment" covers all beach-associated activities, whether replacement or creation; "fill" is the supplementation or creation of above-water areas for development; and "aggregate" specifies sand and/or gravel and shells for commercial uses.

e. Available data: Physical, chemical, and biological data are entered in this item. Physical data include topographic profiles or grain-size analyses; chemical data are water-quality data; and biological data describe examinations of animal life.

f. Alterations: No standard terms are used, but this entry reflects any subsequent alterations.

g. Shape: The terms "circular," "rectangular," "linear," and "irregular" are descriptive terms used. "Circular" denotes that all diameters are essentially equal; "rectangular" denotes that one side is ≤ 3 times the perpendicular side; "linear" denotes a rectangular shape in which one side is >3 times the other; and "irregular" denotes those cases in which none of the above descriptions apply.

h. Size: Self-explanatory.

i. Bank angle: Measured from the horizontal and reduced to three broad classes: <20 deg, 20-60 deg, and >60 deg.

j. Bed materials: "Sand," "silt," or "clay" are used to identify subaqueous site surface.

k. Water depth: The depth of the subaqueous pit.

32. Locations of continental shelf and slope depression, trenches, or canyons have been omitted due to scaling problems involved. These locations are given in the works by Shepard,[11,12] Shepard and Dill,[1] Shepard and Inman,[13] Inman,[14] Drake and Gorsline,[15] and Uchupi.[2] Most of these references cover physical descriptions and current-sediment transport.

33. Dredged channels, berths, and canals were not included in the inventory because the purpose of the study effectively precluded these features. Occasionally, some overlap occurred where depressions were located along or adjacent to shipping channels, and judgments were used to exclude or include them. Generally, these contiguous features were included when the bottom was substantially lower than the vessel drafts.

Several subexamples occurred in the Baltimore District.[16]

34. Figures 2-34 and Tables 1-118 present the data collected during this study. The figures and tables appear at the end of the text to avoid a lengthy interruption. For the reader's convenience, each site map is followed by the appropriate data tabulations.* The data are presented in an alphabetical arrangement of the CE Districts in which the subaqueous pit occurs.

---

* References mentioned in the tables are consecutive to those mentioned in the text.

PART V: SUBAQUEOUS PIT, HOLE, OR DEPRESSION DESCRIPTIONS

35. The subaqueous sites inventoried possessed a wide range of attributes pertinent to this study. The selection of qualitative terms to describe these dissimilarities made it difficult to group sites with similar characteristics. A reasonable approach was a division of sites into the three previously used categories: trenches and canyons, shell dredging sites, and beach replenishment or construction material dredging sites. Some of the extreme subaqueous site characteristics collected were also included so that a broad spectrum of types could be presented.

Trenches or Canyons

36. Canyons off the coast of the United States have a wide variation of descriptive attributes. Tabulations by Shepard and Dill[1] indicate lengths ranging from 3 to 60 nautical miles heading in 30 to greater than 800 ft of water. The canyons traverse the continental slopes with gradients of 125 to 530 ft per mile before emptying at depths of 900 to 10,200 ft. Longitudinal profiles are generally concave upward with a cross section presenting a predominately V-shaped profile.

37. The west coast trenches and canyons are much nearer shore than the east coast canyons. Probably the deepest and largest canyon on the west coast is Monterey Canyon, California.[1] This canyon extends from about 98 ft from Moss Landing in Monterey Bay to the Monterey Fan Valley, a distance of 51 miles. The depths range from 60 ft at the head to 9,600 ft at its junction with the Fan Valley. Terrigenous sediments in the canyon have been reported to a depth of 13,500 ft. The gradient ranges from a high of 670 ft per mile near its head to 105 ft per mile at its lower end.

38. Several other west coast canyons head nearly as close to the shore and extend to deep oceanic basins. In most canyons investigated (Shepard,[12] Drake and Gorsline,[15] and Inman[14]) the down-canyon transport of materials was confirmed. Shepard[12] reported that sand at depths

greater than 11,500 ft in the San Diego trough was probably transported down-canyon.

39. The east coast canyons usually head more than 60 miles from the coast and are essentially limited to that portion of the continental slope north of Cape Lookout, North Carolina.[2] The largest of these is the Hudson Canyon. Shepard and Dill[1] reported that this site was first referred to by Dana in 1864, making it one of the first canyons to be recognized. Shepard and Dill's account reveals that Hudson Canyon heads in 295 ft of water and runs into a fan valley at an approximate depth of 7,000 ft with a gradient progressing from about 135 ft per mile at its head to approximately 80 ft per mile at its confluence with the fan valley. This composite fan is traversed by the valley for some 200 miles to a depth of at least 15,000 ft. The remainder of the east coast canyons are decidedly smaller, and none pierce the 330-ft contour.

40. The continental shelf along the east coast is not traversed by canyons; however, the Hudson Channel extends from New York Harbor nearly across the continental shelf, terminating just prior to reaching the continental slope. Small depressions less than 60 ft deep occur along the length of the channel.[1]

41. Shepard and Dill[1] also report that small ravines or gullies cross portions of the advancing Mississippi River Delta front, but none are of any great magnitude, either in depth or lateral extent.

Beach Replenishment or Construction Aggregate Sites

42. Beach replenishment operations leave pits of various sizes, depending upon the shape of the source and the replenishment areas, in addition to the quantity of sand to be emplaced. A long section of beach to be restored usually results in a long borrow area and pit, provided the source is continuous. If not, the borrow area will be exploited with additional effort expended to emplace the sand at the correct point(s). The width of borrow zone is usually dependent upon the depth of material available, effective operating depths of the dredge, or the quantity of material required. The last factor usually

has the strongest influence as source depths and effective operating depths are fairly consistent.

43. Numerous beach restoration projects have been accomplished along the eastern coast of the United States, beginning in the northeast and progressing to the southeast. Beach fill was noted by Taney[17] to have been placed at Coney Island, New York, as early as 1923, but the source, subaerial or subaqueous, was not specified. Scattered accounts record a few restoration projects during the 1930's and 1940's, but the beach rehabilitation programs gained momentum in the 1950's and 1960's.

44. Murawski,[3] Russell,[18] Escoffier and Dolive,[19] Watts,[20,21] Vesper,[22-24] and Mauriello[25,26] reported a rather wide range of borrow pit characteristics. An extreme case of linearity is the borrow pit created when the Harrison County, Mississippi, beaches were restored. This pit when dredged in 1951 was 14 ft deep and approximately 100 ft wide and extended for approximately 25 miles. The yield was approximately 6 million cu yd of material.

45. Beaches in the northeast United States have been the recipient of many replenishment projects. Some of the beaches have been repeatedly replenished as indicated by the profiles reproduced by Vesper.[24] These replenishment projects have usually used less than 1 million cu yd of material with most of the sites using approximately 500,000 cu yd. Most topographic profiles indicate widths of 500 to 600 ft, lengths varying from 1,000 to 3,000 ft, and water depths ranging from 5 to 20 ft. Most excavations seem to be approximately 20 ft deep with side slopes of 10 to 20 deg.

46. The sediment accumulation rates in these pits are dependent upon distance from shore and normal wave action and sediment transport across the borrow area. Vesper[24] indicated that, based on records 4 years apart, the pit remaining at the Sherwood Island State Park, Westport, Connecticut, would take 63 years to fill. Watts' report for the Harrison County beach restoration indicated a 20-year lifespan (1951-1971) for the resulting borrow pit.[20]

47. Several beach replenishment programs have been accomplished or are planned for the Florida coast. These projects are, for the most

part, recent and represent an increase in the quantities of material involved. This increase is probably due to an improvement in the delivery system as well as increased demands by the public for more and better maintained recreation areas.

48. Watts[21] reported general statistics for two of these areas. The Pompano Beach, Florida, area was replenished with approximately 1 million cu yd of sand dredged from nearly one mile offshore. The resulting pit is in approximately 40 to 70 ft of water. The Treasure Island, Florida, effort involved 800,000 cu yd from a zone 2,000 ft offshore. The resulting 20-ft-deep pit is covered by 12 to 15 ft of water. This borrow zone is filling with fine-grained material at a rate of 7 ft per year. (This figure indicates complete filling now as the work was accomplished in 1969.)

49. Large-scale beach replenishment was initiated on the west coast with Redondo Beach, California, in 1968 when 1,400,000 cu yd of material was moved. Irregular areas 15 to 20 ft deep were created in an area 700 by 10,000 ft located approximately 1,200 ft offshore. Profiles indicate that this area is being rapidly filled.

50. Murawski's collection of data on pits formed through dredging for construction on fill material constitutes the largest single source of descriptive data currently available.[3] His data indicate that these areas are extremely variable in areal extent and depth. Subaqueous pits remaining after the removal of fill material relate directly to the amount of material needed, hence the variability. It is probable that economics play a substantial role in determining the minimum size area to be exploited, and some estimate could be made of a normal minimum dimension pit. However, a prevalent size does not seem to exist.

51. On the other hand, the construction of the offshore drilling islands as reported by Russell[27] would have to qualify as one of the largest efforts ever attempted. This trench in the San Diego Harbor is reported to be 250 ft wide and 75 ft deep. These dimensions necessitate a length of nearly 2,000 ft to obtain the approximately 3,300,000 cu yd used.

Shell Dredging Subaqueous Sites

52. Subaqueous sites remaining after the removal of shell for base material and cement manufacture are usually discontinuous, randomly oriented linear depressions. The Mobile District[6] reported that these pits average 400 ft in width and may extend for a cumulative distance of 20 miles per year. Also reported were probable average depths after dredging of 5 to 10 ft below the natural bottom. Undoubtedly, these statistics vary in other areas and are dependent upon the depth of overburden, the thickness of the bed being exploited, and the success of depositing the overburden and wash sediments in the previously dredged trench.

53. The Galveston District[5] reports that shell dredging is less random, depending upon the location of the deposit and the capacity of the dredge. The original trenches are probably about 35 ft deep but are refilled to a depth of approximately 10 ft and maintain steep, nearly vertical sides. Old dredged cuts (10 to 12 years old) have filled to normal depth and are physically similar to surrounding natural bottoms.

54. Therefore, trenches remaining after shell dredging are probably some 400 ft wide, 5 to 10 ft deep, possess near-vertical sides, and revert to near-normal conditions in a relatively short period of time.

PART VI: POTENTIAL SUBAQUEOUS PIT, HOLE, OR DEPRESSION SITES

55. The potential of creating new subaqueous sites as depositories for dredged material is very high. Indications are that man's activities that create subaqueous sites are going to increase. All aspects previously considered (trenches and canyons, beach rehabilitation, construction material requirements, and shell dredging) do not share equally in this potentiality. Quite obviously, barring catastrophic geologic events, the number of submarine trenches and canyons is not going to increase. Similarly, shell dredging should not experience any extraordinary increase. Thus, the fields of beach rehabilitation and the extraction of construction materials possess the greatest potential. Trenches and canyons are considered as existing sites and will be omitted from this discussion. The potentials of the other two activities are discussed in the following paragraphs.

Beach Replenishment or Construction Aggregate Potential

56. The potential for developing new subaqueous sites for beach replenishment and construction material is dependent on three requirements: a demonstrable need, a suitable source of material, and an economical, socially acceptable method of execution.

57. The requirement for shore protection or beach replenishment is continually being demonstrated. Coastal communities are dependent upon control of the shoreline for their well-being. Similarly, areas devoted to recreation must be maintained for the needs of both the coastal community's economic survival and for the participating population's recreational activities. There is little doubt that the shores and beaches will be maintained as long as practical.

58. New sources of coarse-grained construction materials are a requirement of the ever-expanding community. The need for these materials is increasing, and the extinction of economical terrestrial sources seems to dictate a requirement for subaqueous sources. This need has already become critical for several major coastal metropolitan areas.

59. The location of suitable supplies of these materials has been initiated on several fronts and current results are promising. Duane's reports[28,29] list sand sources of more than 600 million cu yd in six areas off the Florida coast from Dade County north to and including Duval County and 1500 million cu yd off the New Jersey coast. The Florida survey indicates a fine sand to the north with the southern deposits containing more shell.

60. Duane and Meisburger[30] report the availability of more than 540 million cu yd of sand along the Florida coast from Miami to Palm Beach. The southern portion (25°40' N to 26°20' N) contains 160 million cu yd of a delicate calcareous sand in a reef-interreef flat complex. The nearshore or first interflat deposits are less than 5 ft thick. The second flat, 1 to 3 miles offshore, contains 5- to 15-ft-thick deposits in 35 to 50 ft of water, and the outer deposits are of similar thicknesses. The northern deposit (26°20' N to 26°48' N) contains about 380 million cu yd of fine to medium sand. These deposits thin from approximately 40 ft at the shore to 0 ft at some 4500 ft offshore. Meisburger[31] has investigated sediment deposits near the Chesapeake Bay Entrance and reported the location of about 213 million cu yd of coarse sand. More than half of these deposits occur in Thimble Shoals, and remaining deposits are within the bay entrance and vicinity and are overlain by less than 5 ft of fine-grained material.

61. Schlee[32] reported the probable existence of a 560-square-mile deposit of gravel with a possible thickness of 10 to 30 ft off the New Jersey shore between the Hudson Channel and the coast immediately east of Barnegat Inlet. Extensive sand deposits flank the gravel deposit. Potential markets for these materials exist along Staten Island, 70 miles north of the deposits, and Atlantic City, 35 miles south of the deposits.

62. Goodier and Nalwalk[33] have attempted to locate deposits to supplement Connecticut's dwindling terrestrial supplies. Primary exploration is in the Long Island and Fisher Island Sounds. These areas are believed to contain extensive deposits.

63. New York State consumes a large quantity of coarse-grained building materials, and subaqueous supplies furnish a large portion used

along the coast. Even as early as 1929, Nevin[34] reported sand dredging on Lakes Erie and Ontario and Long Island Sound. These were skimming operations but would seem to indicate exploitable sources. Hartley[35] inventoried the Lake Erie sand dredging areas for their potential and reported resources in excess of 500 million cu yd as of the mid-1950's. The areas surveyed were Maumee Bay, Cedar Point, Lorain-Vermilion, and Fairport; these deposits contained scattered gravels.

64. Extensive inventories of sand and gravel resources in California reported by Goldman did not include offshore deposits.[36-40] However, some beach deposits were noted in the Monterey Bay area. Goldman states that the terrestrial sources, unless regulated and/or protected, could be depleted in three decades. Prior to depletion of the land sources, subaqueous material should be investigated for future development.

65. Exploitation of additional offshore subaqueous material will require further incentives for technological development in the dredging industry. The Pacific Coast Engineering Company has furnished controlled environment dredges capable of discharging 200 cu yd per hour from a suction depth of 200 ft.[41] Herbich[42] reports hopper dredges operating at suction depths of 105 ft, and Mauriello's report[25] shows the feasibility of using these dredges for beach rehabilitation. Ellicott Machine Corporation[43] has developed submersible dredge pumps, so it would appear that the feasibility of increasing working depths is primarily a question of economics.

Shell Dredging Potential

66. The shell dredging industry is primarily concerned with cement manufacture, poultry feed supplements, and filler for asphaltic products. The requirement of shell for all these uses is continually expanding. The shell dredging industry is exploiting a practically nonrenewable resource, so it faces conversion at some future date that will probably be determined purely on the basis of economy. However, until the economic

situation changes, shell is expected to be a highly sought-after exploitable resource.

67. Dead shell reserves are known to exist in the bays and estuaries from North Carolina southward to Florida, and thence westward in the Gulf to the Texas-Mexico border. In fact, probably all coastal environments now supporting a shellfish population have some quantity of dead shell that can be exploited, but no long-term production plans have resulted in detailed inventories of State supplies. Alabama Fish and Wildlife[6] estimated that the Alabama reserves total some 46 million cu yd and at the current usage rate would last less than 30 years. The Galveston District[5] reported that the Texas reserves were not known, and no estimates were obtained for any other shell-producing states. However, according to U. S. Department of the Interior,[44] approximately 90 percent of the shell production is from the Gulf Coast states, so it would seem that most of the reserves are probably located in these estuaries and bays.

68. The equipment necessary to exploit these resources is readily available. Dredges operating to depths greater than 50 ft[45] are currently available, and the technology exists to increase this capability to accommodate deeper deposits. However, the possibility of using these pits as dredged material depositories is remote. Two primary reasons are their shallow and irregular nature and their propensity toward rapid filling by sediments transported across the shallow bay and estuary bottoms.

PART VII: DISCUSSION OF RESULTS AND CONCLUSIONS

Discussion of Results

69. The location of subaqueous pits, holes, or depressions and knowledge thereof is related to three types of man's exploitation and one natural phenomenon. Man-controlled causes (extraction of shell from estuarine or bay bottoms, transfer of sand from offshore sources to onshore or nearshore locations, and removal of coarse-grained material for construction and site development) are related to location of subaqueous material and to material requirements. Shell extraction is primarily dependent upon source location, and using facilities can be constructed in the vicinity of the source. Beach replenishment is directly related to the requirement for and secondly related to the source of material. The removal of coarse-grained construction material is dependent both upon the need and source, as measured by a cost-benefit ratio. Natural pits, holes, or depressions are simply related to geological history: man's activities may alter their characteristics, but demand cannot alter their supply.

70. The research accomplished in connection with the various types of subaqueous pits is in turn oriented toward the primary requirement, the potential of subaqueous pits as dredged material disposal sites. Research with shell dredging operations has responded to the problems of effective removal of sediment (dredge design) and suspended sediment effects. Neither of these furnish much insight into the factors of pit creation, environmental effects, or pit life. The only attributes that may be extrapolated to these factors are that dredge design now permits economic operation at depths greater than 50 ft and that most sediment picked up and subsequently discharged returns to the dredged path or pit. Recently required environmental impact statements contain information indicating that the transition from shallow (5-10 ft) shell dredged pits to normal bottom conditions is a relatively short (<15 years) time and that no long-term detrimental effects are created.

71. The existence of areas containing or likely to contain pits

is well known, but the shell dredging process creates a multitude of narrow (approximately 400 ft), variable-length, randomly oriented pits that tend to preclude accurate locations of particular pits. Conversely, the propensity of the pits to occur in reasonable proximity to one another aids in subsequent locations.

72. Research in the field of beach replenishment is designed to verify beach stability and to discover the contributing or destructive causes. Little attention is paid to the offshore borrow zone, except in establishing that it is far enough offshore not to contribute to sand losses from the beach. Some thought is given to suspended sediment increases, but these increases are usually negligible. Recent efforts have attempted to include the borrow zone in the research efforts as indicated by the work being done in the Treasure Island, Florida, area. Other areas have been monitored to determine subsequent fill rate, but the information gained furnishes no basis for specific conclusions. The fill rate is probably controlled by the sediment movement across the adjoining flats. Several references that deal with this subject were examined and are included in the Bibliography.

73. Future beach replenishment projects will be located in areas where beach erosion is a dominant factor, such as the beaches of southern Long Island, New York. Nearly all eroding beaches have a source of suitable sand near enough to furnish the necessary replenishment. Pit locations will be at that part of the source most convenient to the beach, unless other factors (previously exploited areas, extension of existing pits, or conflicting uses) dictate other locations. These pits are usually easy to locate due to size and proximity to beach nourishment projects.

74. Pits left after the removal of construction aggregate or fill material have received little attention. Murawski's efforts were the only major contribution discovered during this study. It would seem that the major contributor to this situation is that the resulting hole is always a liability (lack of fill or construction material), and no one has cared to initiate extensive research.

75. Future pits remaining after the removal of coarse-grained

construction material will probably be clustered around the large coastal metropolitan areas. These sprawling areas are the first hit by the transportation cost, which, at the present time, usually controls the economical operation of borrow activities. The factors of material availability, mix, and suitability naturally affect pit operation; but given equal terrestrial and subaqueous sources, the high terrestrial transportation cost is what makes the subaqueous operation attractive. This transportation cost will be extrapolated to determine the offshore distance that is economically attractive. The locations of these pits will initially be nearshore and slowly creep seaward.

76. The number of construction and borrow material pits will not show a rapid increase in the near future. Three factors support this probability: (a) terrestrial supplies are critical only in a very select portion of the country; (b) the collection of the material is a skimming operation in a large majority of the construction material gathering operations; and (c) the operations that contribute to a pit will be adjoining areas where the pit will simply become part of the channel, or in some operations will be worked for a long time. This last effect will probably create a few super pits rather than numerous small ones.

Conclusions

77. Research to date on the effects of pits, holes, or depressions on the aqueous environment or on the life forms inhabiting them has been limited. Recent requirements for environmental impact statements have encouraged some work that can be used to furnish a basis for future research. A probable effect of the increasing requirements of additional sources of coarse-grained construction materials and sand for beach nourishment programs will be a decided upswing of research efforts covering the whole spectra of the operation. Likewise, the public awareness usually involved with estuarine dredging will probably lead to some detailed research on shell dredging.

78. Requirements for extraction of materials that form subaqueous

pits may show an increase in the near future. More shoreline will be protected and replenished by the emplacement of transported sand. The demand for additional reaches of beach will necessitate more effort devoted to less attractive coastal sections in order to furnish recreational space. Terrestrial sources of coarse-grained construction material for the major coastal metropolitan areas will decrease, which will necessitate exploitation of subaqueous sources.

79. The construction and poultry feed industries will continue to demand an increasing supply of shell. This activity will push operation into all available estuaries and bays to try to balance an increasing demand with a decreasing supply.

80. Sources of subaqueous coarse-grained construction material are both plentiful and widespread. The majority of the coastal cities are close enough to a currently known supply to enable economical use of these sources. The major concern should be to develop economical methods of survey so as to obtain an accurate inventory necessary for the orderly development of the industry and in turn useful subaqueous pits.

81. Sources of sand for beach rehabilitation are almost boundless with nearly any beach being in reach of an economically exploitable deposit. The natural movement, if any, of these supplies must be charted and the supplies inventoried to ensure optimum development.

REFERENCES

1. Shepard, F. P. and Dill, R. F., Submarine Canyons and Other Sea Valleys, Rand McNally, Chicago, 1966.
2. Uchupi, E., "Maps Showing Relation of Land and Submarine Topography, Nova Scotia to Florida," Miscellaneous Geologic Investigation Map 1-451, 1965, U. S. Geological Survey, Washington, D. C.
3. Murawski, W. S., "A Study of Submerged Dredge Holes in New Jersey Estuaries with Respect to Their Fitness as Finfish Habitat," Miscellaneous Report No. 2M, Oct 1969, New Jersey Department of Conservation and Economical Development, Trenton, N. J.
4. Masch, F. D. and Espey, W. H., Jr., "Shell Dredging, A Factor in Sedimentation in Galveston Bay," Technical Report No. HYDRO66702 CRWR-7, 1967, University of Texas, Austin, Tex.
5. U. S. Army Engineer District, Galveston, CE, "Shell Dredging in San Antonio Bay, Texas," Final Environmental Impact Statement, 25 Apr 1974, Galveston, Tex.
6. U. S. Army Engineer District, Mobile, CE, "Final Environmental Impact Statement - Permit Application by Radcliff Materials, Inc., Mobile Bay, Alabama," Feb 1973, Mobile, Ala.
7. May, E. B., "Environmental Effects of Hydraulic Dredging in Estuaries," Bulletin No. 9, Apr 1973, Alabama Marine Resources Laboratory, Dauphin Island, Ala.
8. __________, "Extensive Oxygen Depletion in Mobile Bay," Limnology and Oceanography, Vol 18, No. 3, May 1973, pp 353-366.
9. Gustafson, J. F., "Ecological Effects of Dredged Borrow Pits," World Dredging and Marine Construction, Sep 1972, pp 44-48.
10. Polis, D. F., "The Environmental Effect of Dredge Holes - Present State of Knowledge," May 1974, Water Resources Administration, Annapolis, Md.
11. Shepard, F. P., "Canyons Off the New England Coast," American Journal of Science, 5th Series, Vol XXVII, No. 157, Jan 1934, pp 24-36.
12. __________, "Sand and Gravel in Deep Water Deposits," World Oil, Vol 132, No. 1, Jan 1951, pp 61-68.
13. Shepard, F. P. and Inman, D. L., "Sand Movement on the Shallow Inter-Canyon Shelf at La Jolla, California," Technical Memorandum No. 26, Nov 1951, Beach Erosion Board, CE, Washington, D. C.
14. Inman, D. L., "Submarine Topography and Sedimentation in the Vicinity of Mugu Submarine Canyon, California," Technical Memorandum No. 19, Jul 1950, Beach Erosion Board, CE, Washington, D. C.

15. Drake, D. E., and Gorsline, D. S., "Distribution and Transport of Suspended Particulate Matter in Hueneme, Redondo, Newport, and La Jolla Submarine Canyons, California," Geological Society of America Bulletin, Vol 84, Dec 1973, pp 3949-3968.

16. U. S. Army Engineer District, Baltimore, CE, "Environmental Impact Statement - Permit Application for Diked Disposal Island, Hart and Miller Island, Maryland," Feb 1973, Baltimore, Md.

17. Taney, N. E., "Geomorphology of the South Shore of Long Island, New York," Technical Memorandum No. 128, Sep 1961, Beach Erosion Board, CE, Washington, D. C.

18. Russell, J. E., "Behavior of Project Beach Fills," Shore and Beach, Vol 41, No. 1, April 1973, pp 19-21.

19. Escoffier, F. F. and Dolive, W. L., "Shore Protection in Harrison County, Mississippi," Bulletin, Beach Erosion Board, Vol 8, No. 3, Jul 1954, pp 1-12.

20. Watts, G. M., "Behavior of Beach Fill and Borrow Area at Harrison County, Mississippi," Technical Memorandum No. 107, Aug 1958, Beach Erosion Board, CE, Washington, D. C.

21. __________, "Offshore Dredging for Beach Nourishment Projects Surveyed," World Dredging and Marine Construction, Vol 10, No. 6, Jun 1974, pp 21-23.

22. Vesper, W. H., "Behavior of Beach Fill and Borrow Area at Prospect Beach, West Haven, Connecticut," Technical Memorandum No. 127, Aug 1961, Beach Erosion Board, CE, Washington, D. C.

23. __________, "Behavior of Beach Fill and Borrow Area at Seaside Park, Bridgeport, Connecticut," Technical Memorandum No. 11, Feb 1965, U. S. Army Coastal Engineering Research Center, CE, Fort Belvoir, Va.

24. __________, "Behavior of Beach Fill and Borrow Area at Sherwood Island State Park, Westport, Connecticut," Technical Memorandum No. 20, May 1967, U. S. Army Coastal Engineering Research Center, CE, Fort Belvoir, Va.

25. Mauriello, L. J., "Experimental Use of a Self-Unloading Hopper Dredge for Rehabilitation of an Ocean Beach," Proceedings, WODCON, World Dredging Conference, Palos Verdes Estates, Calif., 1967, pp 367-395.

26. __________, "Beach Rehabilitation by Hopper Dredge," Journal, Waterways, Harbors, and Coastal Engineering Division, American Society of Civil Engineers, Vol 94, No. WW2, May 1968, pp 175-188.

27. Russell, J. S., "Dredging of Offshore Drilling Islands," Proceedings, WODCON, World Dredging Conference, Palos Verdes Estates, Calif., 1967, pp 21-29.

28. Duane, D. B., "Sand Inventory Program in Florida," Shore and Beach, Vol 36, No. 1, Apr 1968, pp 12-15.

29. Duane, D. B., "Sand Deposits on the Continental Shelf: A Presently Exploitable Resource," Transactions, National Symposium on Ocean Science and Engineering of the Atlantic Shelf, Marine Technological Society, Philadelphia Section, Mar 1968, pp 289-297.

30. Duane, D. B. and Meisburger, E. P., "Geomorphology and Sediments of the Nearshore Continental Shelf, Miami to Palm Beach, Florida," Technical Memorandum No. 29, 1969, U. S. Army Coastal Engineering Research Center, CE, Fort Belvoir, Va.

31. Meisburger, E. P., "Geomorphology and Sediments of the Chesapeake Bay Entrance," Technical Memorandum No. 38, Jun 1972, U. S. Army Coastal Engineering Research Center, CE, Fort Belvoir, Va.

32. Schlee, J., "New Jersey Offshore Gravel Deposit," Pit and Quarry, No. 57, December 1964, pp 80-81, 95.

33. Goodier, J. L. and Nalwalk, A. J., "Marine Mineral Identification Survey of Coastal Connecticut," Offshore Technical Conference, OTC - 1028, May 1969, pp 265-276.

34. Nevin, C. N., "The Sand and Gravel Resources of New York State," Bulletin No. 282, Jun 1929, New York State Museum, Albany, N. Y.

35. Hartley, R. P., "Sand Dredging Areas in Lake Erie," Technical Report No. 5, 1960, Department of Natural Resources, Columbus, Ohio.

36. Goldman, H. B., "Sand and Gravel," Mineral Resources of California, Bulletin No. 191, pp 361-369, 1966, California Division of Mines and Geology, Sacramento, Calif.

37. _________, "Sand and Gravel in California; Part A, Northern California," Bulletin No. 180-A, 1961, California Division of Mines and Geology, Sacramento, Calif.

38. _________, "Sand and Gravel in California; Part B, Central California," Bulletin No. 180-B, 1964, California Division of Mines and Geology, Sacramento, Calif.

39. _________, "Sand and Gravel in California; Part C, Southern California," Bulletin No. 180-C, 1968, California Division of Mines and Geology, Sacramento, Calif.

40. _________, "Sands, Speciality," Mineral Resources of California, Bulletin No. 191, pp 369-374, 1966, California Division of Mines and Geology, Sacramento, Calif.

41. "New Dredge for Ghana," The Dock and Harbour Authority, Vol XLV, No. 527, Sep 1964, pp 164-165.

42. Herbich, J. B., "Dredging Methods for Deep-Ocean Mineral Recovery," Journal, Waterways, Harbors, and Coastal Engineering Division, American Society of Civil Engineers, Vol 97, No. WW2, May 1971, p 385.

43. Turner, T. M., "Dredging Seminar," Notes presented at U. S. Army Engineer Waterways Experiment Station, CE, Dredging Seminar, Vicksburg, Miss., Jun 1974, Ellicott Machine Corporation, Baltimore, Md.

44. U. S. Department of the Interior, "The National Estuarine Pollution Study," Report of the Secretary of the Interior to the United States Congress, Senate Document No. 91-58, pp 1-633, 1970, Washington, D. C.

45. "Southern Industries New Shell Dredge - Complete 800 TPH Plant Afloat," Pit and Quarry, Vol 58, No. 3, Sep 1965, pp 91-93.

46. Worcester County Sanitary District, permit application, revised 22 Feb 1972.

47. Great Lakes Laboratory, "Sand Evaluation of the Ecological Impact of Dredging on Lake Erie," Aug 1970, State University of Buffalo, N. Y.

48. U. S. Army Engineer District, Jacksonville, CE, "Environmental Impact Statement - Beach Erosion Control Study on Manatee County, Florida," May 1973, Jacksonville, Fla.

49. __________, "Environmental Impact Statement - Mullett Key Beach Erosion Control Project, Pinellas County, Florida," Mar 1972, Jacksonville, Fla.

50. U. S. Department of Commerce, Coast and Geodetic Survey, Miami to Elliott Key, Chart No. 848, 1:40,000, Jul 1965, Washington, D. C.

51. U. S. Army Engineer District, Jacksonville, CE, "Draft Environmental Statement - Beach Erosion Control and Hurricane Protection Project, Dade County, Florida," Jul 1974, Jacksonville, Fla.

52. Park, F. D. R., "Virginia Key - Key Biscayne Beach Nourishment Program," Shore and Beach, Vol 37, No. 1, Apr 1969, pp 32-36.

53. U. S. Army Engineer District, Jacksonville, CE, "Environmental Impact Statement - Beach Erosion Control Project - Delray Beach, Florida," Sep 1972, Jacksonville, Fla.

54. __________, "Final Environmental Impact Statement - Brevard County Beach Erosion Control Project," May 1972, Jacksonville, Fla.

55. Fisher, C. H., "Mining the Ocean for Beach Sand," Proceedings, Civil Engineering in the Oceans II, American Society of Civil Engineers, Dec 1969, pp 717-723.

56. Perdikis, H. S., "Behavior of Beach Fills in New England," Journal, Waterways, Harbors, and Coastal Engineering Division, American Society of Civil Engineers, Vol 87, No. WW1, Feb 1961, p 75.

57. U. S. Department of Commerce, Coast and Geodetic Survey, New York Harbor, Chart No. 369, 1:40,000, 1969, Washington, D. C.

58. __________, Pocomoke and Tangier Sounds, Chart No. 568, 1:40,000, 1972, Washington, D. C.

59. U. S. Department of Commerce, Chesapeake Bay Entrance, Chart No. 1222, 1:80,000, 1973, Washington, D. C.

60. __________, San Francisco Bay, Chart No. 5535, 1:20,000, 1965, Washington, D. C.

61. __________, San Francisco Bay, Southern Port, Chart No. 5531, 1:40,000, Washington, D. C.

62. __________, San Pablo Bay, Chart No. 5533, 1:40,000, 1964, Washington, D. C.

BIBLIOGRAPHY

Arnal, R., "Environmental Studies and Researches for the Communities of Monterey Bay Region" (ongoing), Jul 1973, California State Universities and Colleges, San Jose, Calif.

Biggs, R. et al., "Assateague Ecological Studies," 1970, Natural Resources Institution, University of Maryland, College Park, Md.

Bureau of Economic Geology, University of Texas, "Environmental Geologic Atlas of the Texas Coastal Zone, Galveston-Houston Area," Austin, Tex.

Courtenay, W. R. et al., "Ecological Monitoring of Beach Erosion Control Projects, Broward County, Florida and Adjacent Areas" (in preparation), U. S. Army Coastal Engineering Research Center, Fort Belvoir, Va.

Cruickshank, M. J., Romanowitz, C. M., and Overall, M. P., "Offshore Mining--Present and Future," Engineering and Mining Journal, Jan 1968.

Daly, R. A., "Origin of Submarine Canyons," American Journal of Science, Vol 31, No. 186, 1936, pp 401-420.

Drobeck, K-G., "Comments on Submerged Borrow Areas in Cincoteque, Sinepuxent and Isle of Wight Bays," Assateague Ecological Studies, 1970, pp 183-187, Natural Resources Institution, University of Maryland, College Park, Md.

Engle, J. B., "Dredging for Buried Shell in the Coastal Waters of North Carolina," 1962, U. S. Department of Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries, Biological Laboratory, Oxford, Md.

Ford, R. F. et al., "Marine Organisms of Central San Diego Bay and the Potential Effects of Dredging and Spoil Deposition," Technical Report No. 2, 1971, Sea Science Services.

Gee, H. C., "Beach Nourishment from Offshore Sources," Journal, Waterways, Harbors, and Coastal Engineering Division, American Society of Civil Engineers, Aug 1965.

Goodwin, C. R., "Estuarine Hydrology of Tampa Bay" (ongoing), 1973, U. S. Department of the Interior, Geological Survey, Tallahassee, Fla.

Grant, M. J., "Rhode Island's Ocean Sands: Management Guidelines for Sand and Gravel Extraction in State Waters," Marine Technical Report No. 10, 1973, University of Rhode Island, Kingston, R. I.

Gunter, G., "Reef Shell or Mudshell Dredging in Coastal Bays and Its Effect upon the Environment," Transactions, Thirty-Fourth North American Wildlife and Natural Resources Conference, 1969, pp 51-74.

__________, "Use of Dead Reef Shell and Its Relation to Estuarine Conservation," Transactions, Thirty-Seventh North American Wildlife and Natural Resources Conference, 1972, pp 110-121.

Heizman, L., "Some Soil Mechanical Aspects of Winning Sand at Great Depths and Making Sand Fills Overlaying Poor Subsoils," Proceedings, WODCON World Dredging Conference, Palos Verdes Estates, Calif., 1968, pp 596-603.

Herbich, J. B., Snider, R. H., and Cooper, I. R., "Bibliography on Dredging," Report No. 112-A-CDS, 2d ed., Dec 1970.

Herdendorf, C. E., "Sand and Gravel Resources of the Maumee River Estuary, Toledo to Perrysburg, Ohio," 1970, Division of Geological Survey, Columbus, Ohio.

Hess, H. D., "Sand and Gravel Dredging Reaches Major Proportions," World Dredging and Marine Construction, May 1972, pp 15-18.

Ingle, R. M., "Studies of the Effect of Dredging Operations upon Fish and Shellfish," Technical Series No. 5, 1952, Florida State Board of Conservation.

Inman, D. L. and Rusnak, G. S., "Change in Sand Level on the Beach and Shelf at La Jolla, California," Technical Memorandum No. 82, Jul 1956, Beach Erosion Board, Washington, D. C.

J. B. F. Scientific Corporation, "Proposal for State-of-the-Art Survey and Evaluation of Open Water Dredged Material Placement Methodology," Jan 1974, Burlington, Mass.

Koo, T. S. Y., "Biological Effects of Borrow Pits," 2 Aug 1973, Chesapeake Biological Laboratory, Solomons, Md.

Lehman, E. J., "Pits, Hole and Depressions for Depositing Dredged Materials," May 1974, National Technical Information Service, Springfield, Va.

Ludwick, J. C., "Tidal Currents, Sediment Transport, and Sand Banks in Chesapeake Bay Entrance, Virginia," Technical Report No. 16, Nov 1973, Office of Naval Research, Norfolk, Va.

MacCarthy, G. R., "Coastal Sands of the Eastern U. S.," American Journal of Science, Vol XXII, No. 127, Jul 1931, pp 35-50.

Mackin, J. G., "Canal Dredging and Silting in Louisiana Bays," Publications of the Institute of Marine Science, University of Texas, Vol 7, 1961, pp 262-314.

Manheim, F. T., "Mineral Resources off the Northeast Coast of the U. S.," 1972, U. S. Geological Survey, Washington, D. C.

Michel, J. F., "Offshore Dredging--Challenge of the Future," SNAME Southeast Section Symposium on Dredging, 21-22 Oct 1966.

__________, "Offshore Dredging for Beach Nourishment--Challenge of the Future," Proceedings, WODCON World Dredging Conference, Palos Verdes Estates, Calif., 1967, pp 1-423.

"Modern Dredge for Marine Gravel Production," World Dredging and Marine Construction, Vol 3, No. 3, Sep 1967, pp 1-21.

Newton, J. G. et al., "An Oceanographic Atlas of the Carolina Continental Margin," 1971, Department of Conservation and Development, Raleigh, N. C.

New York State Office of Planning Coordination, "Long Island Sand and Gravel Mining," Jul 1970, Albany, N. Y.

Nicoletti, M. D. V., "Reclamation of Copacabana Beach," Proceedings, WODCON World Dredging Conference, Palos Verdes Estates, Calif., 1970.

Ohio Division of Shore Erosion, "Maumee Bay Sand Survey, 1954," 1955, Columbus, Ohio.

Pennsylvania Water and Power Resources Board, "Report--Comprehensive Studies and Analyses Coal and Sand and Gravel Dredging Industries and Recommending Legislation Providing for Royalties for Coal and Sand and Gravel Recovered from Beds of State Owned Waters," Special Survey, 1936.

Pierce, N., "Inland Lake Dredging Evaluation," 1970, Department of Natural Resources, Madison, Wis.

Shepard, F. P. and Cohee, G. V., "Continental Shelf Sediments off the Mid-Atlantic States," Bulletin, Geological Society of America, No. 47, 1936, pp 441-458.

Sonu, C. J., McCloy, J. M., and McArthur, D. S., "Longshore Currents and Nearshore Topographies," Proceedings, Tenth Conference on Coastal Engineering, Tokyo, Japan, Vol 1, Sep 1966, pp 525-549.

Sonu, C. J. and Russell, R. J., "Topographic Changes in the Surf Zone Profile," Proceedings, Tenth Conference on Coastal Engineering, Tokyo, Japan, Vol 1, Sep 1966, pp 502-524.

Sorensen, A. H., "The Dredging Industry and Ocean Mining," World Dredging and Marine Construction, Jun 1968, pp 1-28.

State University System of Florida, Institute of Oceanography, "A Summary of Knowledge of the Eastern Gulf of Mexico 1973," Mar 1973, St. Petersburg, Fla.

Taney, N. E., "A Vanishing Resource Found Anew," Shore and Beach, Vol 33, No. 1, 1965, pp 22-26.

__________, "A Search for Sand," Shore and Beach, Oct 1966.

Taylor and Salmon, "Some Effects of Hydraulic Dredging and Coastal Development in Boca Ciega Bay, Florida," Fishery Bulletin, Vol 67, No. 2, 1968.

Thoenen, J. R., "Sand and Gravel Excavation," Circular No. 6875, Mar 1936, U. S. Bureau of Mines, Washington, D. C.

Thompson, J. R., "Ecological Effect of Offshore Dredging and Beach Nourishment: A Review," Miscellaneous Paper No. 1-73, 1973, U. S. Army Coastal Engineering Research Center, Fort Belvoir, Va.

Thompson, W. O., "Sandless Coastal Terrain of the Atchafalaya Bay Area," Special Publication, 1953, Texas A&M Department of Oceanography, College Station, Tex.

Trask, P. D., "Movement of Sand Around Southern California Promontories," Technical Memorandum No. 76, Jun 1955, U. S. Beach Erosion Board, Washington, D. C.

U. S. Army Engineer District, Norfolk, CE, "Virginia Beach, Virginia--Beach Erosion Control Project," Draft Environmental Impact Statement, May 1973, Norfolk, Va.

U. S. Army Engineer District, Savannah, CE, "Beach Erosion Control and Hurricane Protection," Draft Environmental Impact Statement, Aug 1973, Savannah, Ga.

__________, "Tybee Island, Georgia--Beach Erosion Control Project," 13 Nov 1973, Savannah, Ga.

U. S. Geological Survey, "Gravel and Sand Resources of the New England-New York Region," Reports--Open File Series No. 289, 1954, Washington, D. C.

U. S. Hydrographic Office, "Inshore Survey Project: A Preliminary Report on the Columbia River Mouth and Its Appraches," HO Miscellaneous Paper No. 15359-21A, 15 Jul 1954, Washington, D. C.

Veatch, A. C. et al., "Atlantic Submarine Valleys of the U. S. and the Congo Submarine Valley," Special Paper No. 7 with charts, 1939, Geological Society of America.

Vinje, J. J., "Siltation in Dredged Trenches," Proceedings, WODCON World Dredging Conference, Palos Verdes Estates, Calif., 1968, pp 851-891.

Watts, G. M., "Behavior of Offshore Borrow Zones in Beach Fill Operations," International Association for Hydraulic Research, 10th Congress, 1963.

Wentworth, C. K., "Sand and Gravel Resources of the Coastal Plains of Virginia," Bulletin 32, 1930, Virginia Geological Society.

Wilson, W. B., The Effects of Sedimentation Due to Dredging Operations on Oysters in Copanao Bay, Texas, M. S. Dissertation, A&M College of Texas, College Station, Tex.

Figure 2. Subaqueous site location, vicinity of Washington, D. C.

Table 1

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Washington, D. C.

Location	Description
Geographic Coordinates	**Shape**
North 38° 46' 10"	Irregular
West 77° 03' 00"	**Size**
CE District Baltimore	Diameter, m NA
State Virginia	Length, m NA
County Fairfax	Width, m NA
C & G Chart 560	Depth, m NA
1:250,000 Topographic Map Washington, D. C.	Area, km^2 NA
Fig. 2 Site 1	**Bank Angle**
History	NA
Initiated 1959	**Environment**
Completed 1969	
Excavation Method	**Bed Materials**
Mechanical	Sand & Gravel
Material Utilization	**Water**
Fill and Aggregate	Depth, m NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: U. S. Army Engineer District, Baltimore, CE.

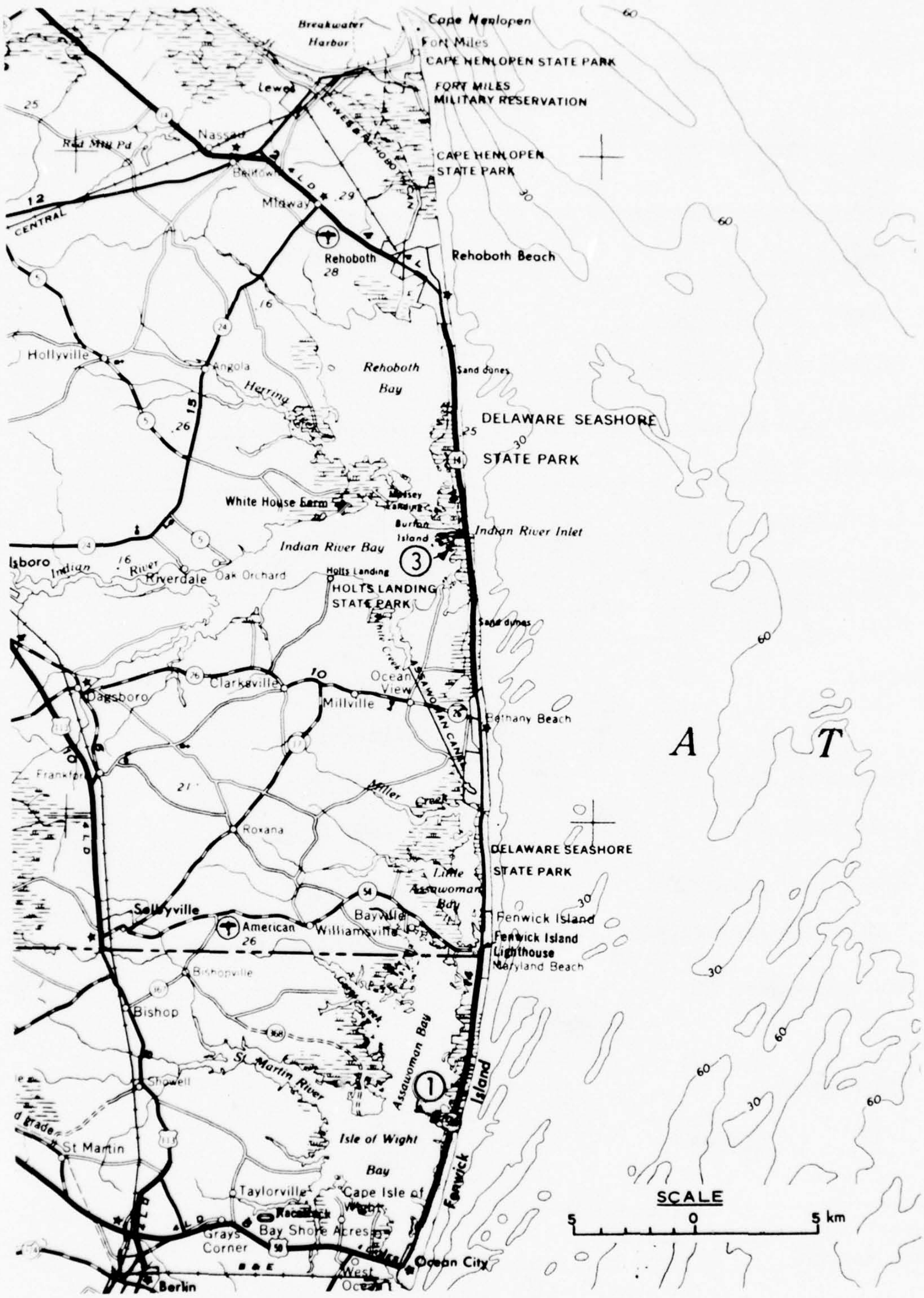


Figure 3. Subaqueous site location, vicinity of Fenwick Island, Maryland

Table 2

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Fenwick Island, Maryland

Location

Geographic Coordinates

North 38° 23' 20"

West 75° 04' 10"

CE District Baltimore

State Maryland

County Worcester

C & G Chart 1220

1:250,000 Topographic Map Salisbury, Md.

Fig. 3 Site 1

History

Proposed

Excavation Method

Hydraulic

Material Utilization

Fill, 230,000 cu yd

Available Data

NA

Alterations

NA

Description

Shape

Rectangular

Size

Diameter, m NA

Length, m 305

Width, m 167

Depth, m 5.5

Area, km^2 0.05

Bank Angle

NA

Environment

Bed Materials

Sand and Silt

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 46.

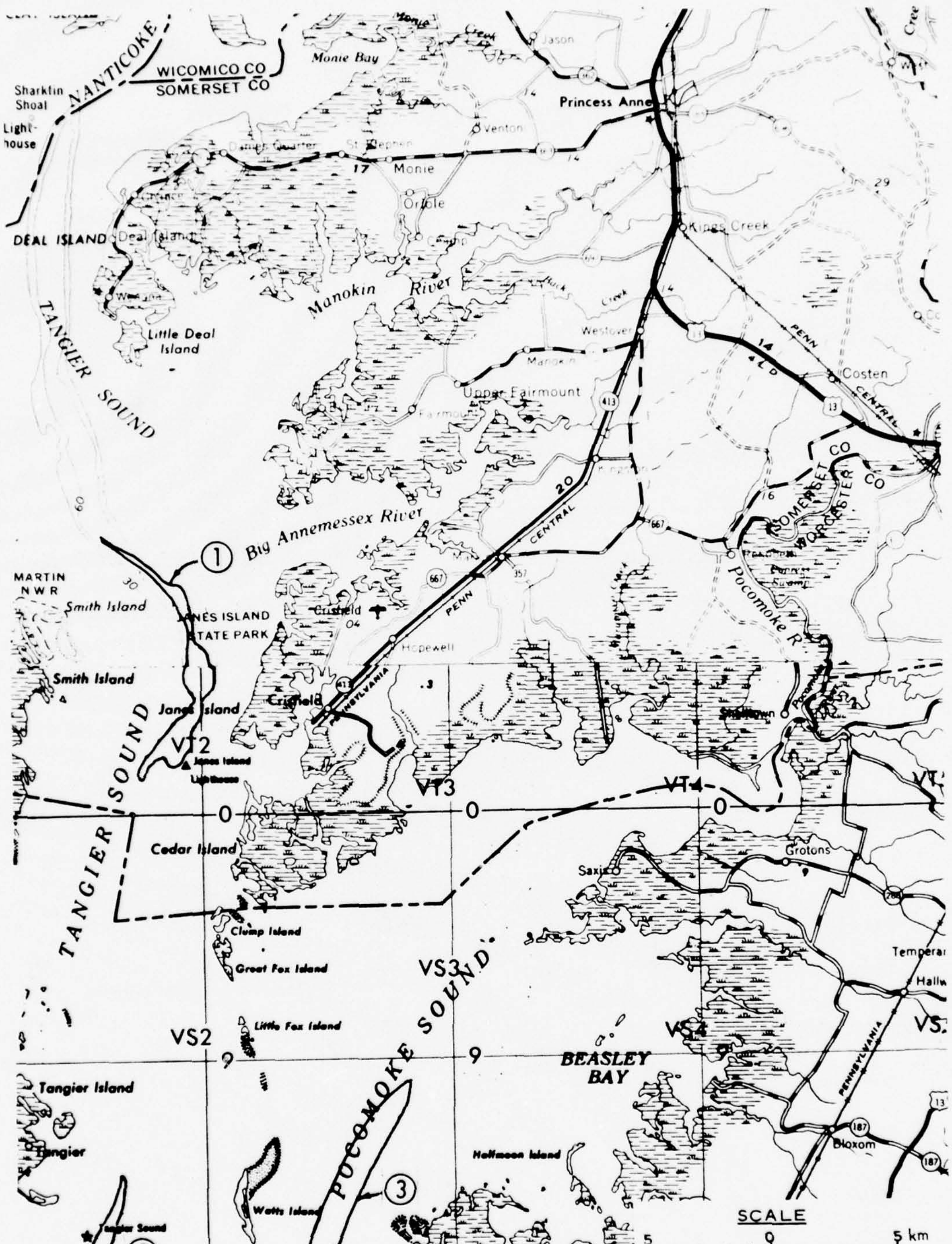


Figure 4. Subaqueous site locations, vicinity of Princess Anne, Maryland

BEST AVAILABLE COPY

Table 3

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Princess Anne, Maryland

Location	Description
Geographic Coordinates	Shape
North 38° 00' 00"	Linear
West 75° 54' 30"	Size
CE District Baltimore	Diameter, m NA
State Maryland	Length, m NA
County Somerset	Width, m NA
C & G Chart 555	Depth, m NA
1:250,000 Topographic Map Salisbury, Md.	Area, km^2 8.36
Fig. 4 Site 1	Bank Angle
	NA
History	
NA	Environment
Excavation Method	Bed Materials
Natural	NA
Material Utilization	Water
NA	Depth, m NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 16.

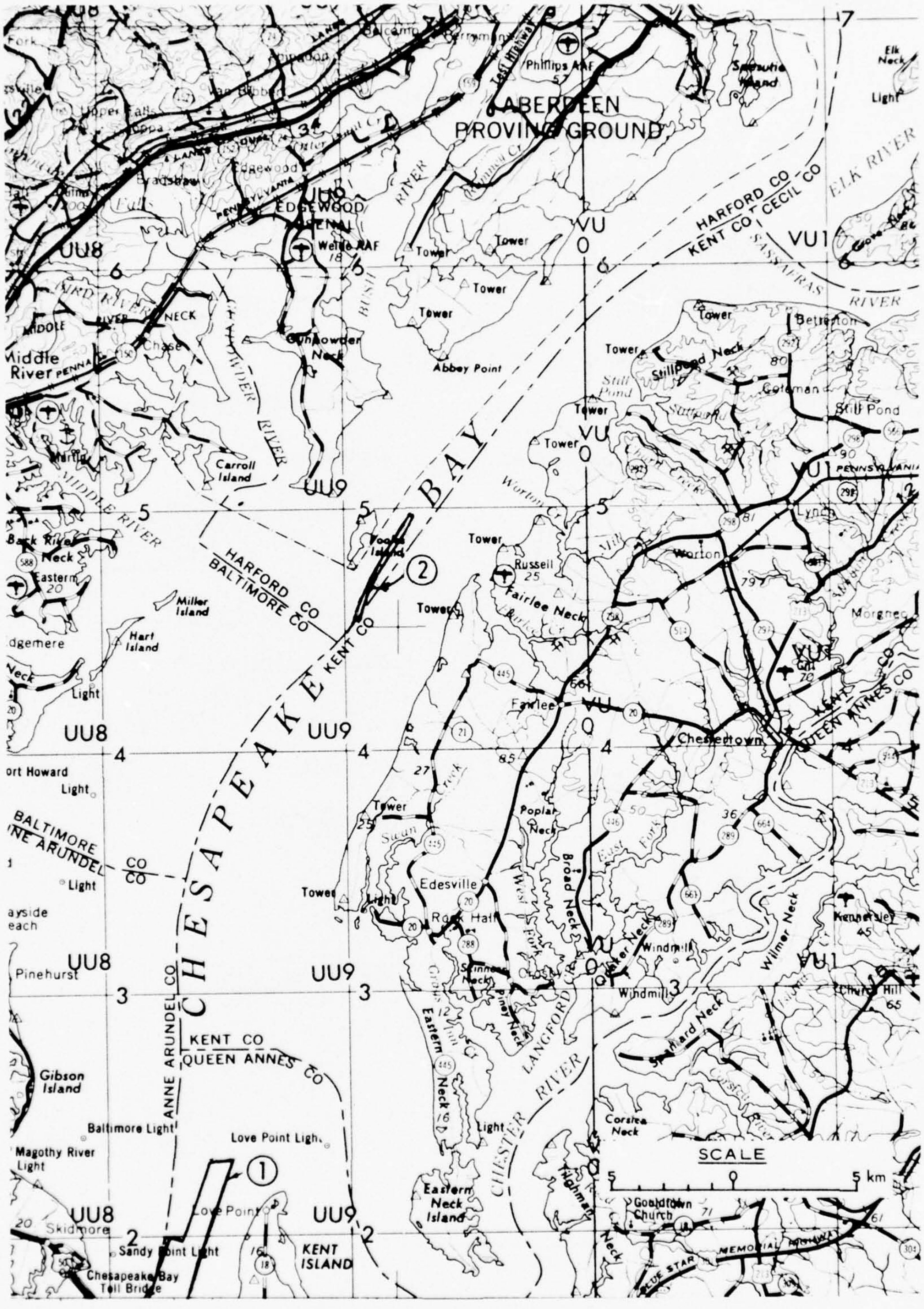


Figure 5. Subaqueous site locations vicinity of Aberdeen Proving Ground, Maryland

Table 4

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Aberdeen Proving Ground, Maryland

Location	Description
Geographic Coordinates	Shape
North 39° 01'	Linear
West 76° 21'	Size
CE District Baltimore	Diameter, m NA
State Maryland	Length, m 7000
County Queen Annes	Width, m 1000
C & G Chart 549-550	Depth, m 15
1:250,000 Topographic Map Washington, D.C.-Baltimore, Md.	Area, km^2 7
Fig. 5 Site 1	Bank Angle
History	NA
NA	Environment
Excavation Method	Bed Materials
Natural	NA
Material Utilization	Water
NA	Depth, m 6 to 15
Available Data	
Physical	
Alterations	
Dredged material disposal	

Note: NA = not available.
Data Source: Reference 16.

Table 5

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, Vicinity of Aberdeen Proving Ground, Maryland

Location	Description
Geographic Coordinates	Shape
North 39° 16' 25"	Linear
West 76° 15' 30"	Size
CE District Baltimore	Diameter, m NA
State Maryland	Length, m 4500
County Harford	Width, m 120
C & G Chart 549	Depth, m 15.2
1:250,000 Topographic Map Baltimore, Md.	Area, km^2 0.540
Fig. 5 Site 2	Bank Angle
History	NA
NA	Environment
Excavation Method	Bed Materials
Natural	NA
Material Utilization	Water
NA	Depth, m NA
Available Data	
Physical	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 16.

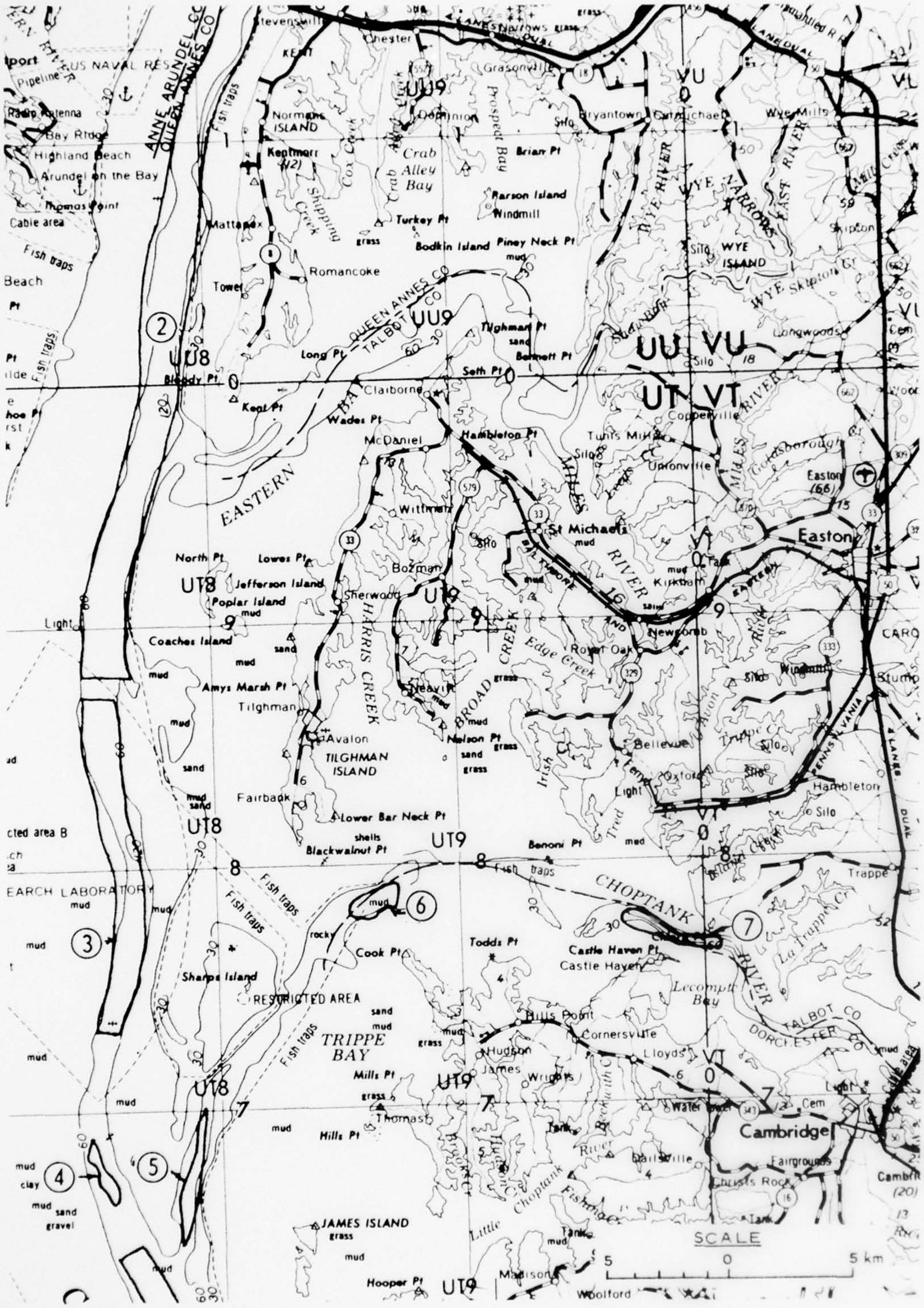


Figure 6. Subaqueous site locations, vicinity of Easton, Maryland

Table 6

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, Vicinity of Easton, Maryland

Location

Geographic Coordinates

North 38° 52' 00"

West 76° 24' 00"

CE District Baltimore

State Maryland

County Anne Arundel, Queen Annes, Talbot

C & G Chart 550

1:250,000 Topographic Map Washington, D.C.

Fig. 6 Site 2

History

NA

Excavation Method

Natural

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 31,000

Width, m NA

Depth, m NA

Area, km^2 41.8

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 16.

Table 7

Subaqueous Pit, Hole, or Depression Characteristics

Site 3, Vicinity of Easton, Maryland

Location

Geographic Coordinates

North 38° 41' 00"

West 76° 25' 30"

CE District Baltimore

State Maryland

County Calvert,Talbot,Dorchester

C & G Chart 551

1:250,000 Topographic Map Washington, D.C.

Fig. 6 Site 3

History

NA

Excavation Method

Natural

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 15,000

Width, m NA

Depth, m NA

Area, km^2 13.4

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 16.

Table 8

Subaqueous Pit, Hole, or Depression Characteristics

Site 4, Vicinity of Easton, Maryland

Location

Geographic Coordinates

North 38° 33' 00"

West 76° 26' 00"

CE District Baltimore

State Maryland

County Dorchester, Calvert

C & G Chart 551

1:250,000 Topographic Map Washington, D.C.

Fig. 6 Site 4

History

NA

Excavation Method

Natural

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 3220

Width, m 550

Depth, m 26.2

Area, km^2 1.17

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m 20

Note: NA = not available.
Data Source: Reference 16.

Table 9

Subaqueous Pit, Hole, or Depression Characteristics

Site 5, Vicinity of Easton, Maryland

Location

Geographic Coordinates

North 38° 32' 30"

West 76° 23' 20"

CE District Baltimore

State Maryland

County Dorchester

C & G Chart 551

1:250,000 Topographic Map Washington, D.C.

Fig. 6 Site 5

History

NA

Excavation Method

Natural

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 5630

Width, m 550

Depth, m 32.0

Area, km^2 3.34

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m 15

Note: NA = not available.
Data Source: Reference 16.

Table 10

Subaqueous Pit, Hole, or Depression Characteristics

Site 6, Vicinity of Easton, Maryland

Location

Geographic Coordinates

North 38° 39' 00"

West 76° 18' 30"

CE District Baltimore

State Maryland

County Talbot, Dorchester

C & G Chart 551

1:250,000 Topographic Map Washington, D.C.

Fig. 6 Site 6

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m 2650

Width, m 1280

Depth, m 16.5

Area, km^2 2.42

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 16.

Table 11

Subaqueous Pit, Hole, or Depression Characteristics

Site 7, Vicinity of Easton, Maryland

Location	Description
Geographic Coordinates	**Shape**
North 38° 38' 00"	Linear
West 76° 10' 00"	**Size**
CE District Baltimore	**Diameter, m** NA
State Maryland	**Length, m** 4570
County Dorchester, Talbot	**Width, m** 457
C & G Chart 551	**Depth, m** 26.2
1:250,000 Topographic Map Washington, D. C.	**Area, km²** 1.672
Fig. 6 **Site** 7	**Bank Angle**
History	NA
NA	**Environment**
Excavation Method	**Bed Materials**
Natural	NA
Material Utilization	**Water**
NA	**Depth, m** NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 16.

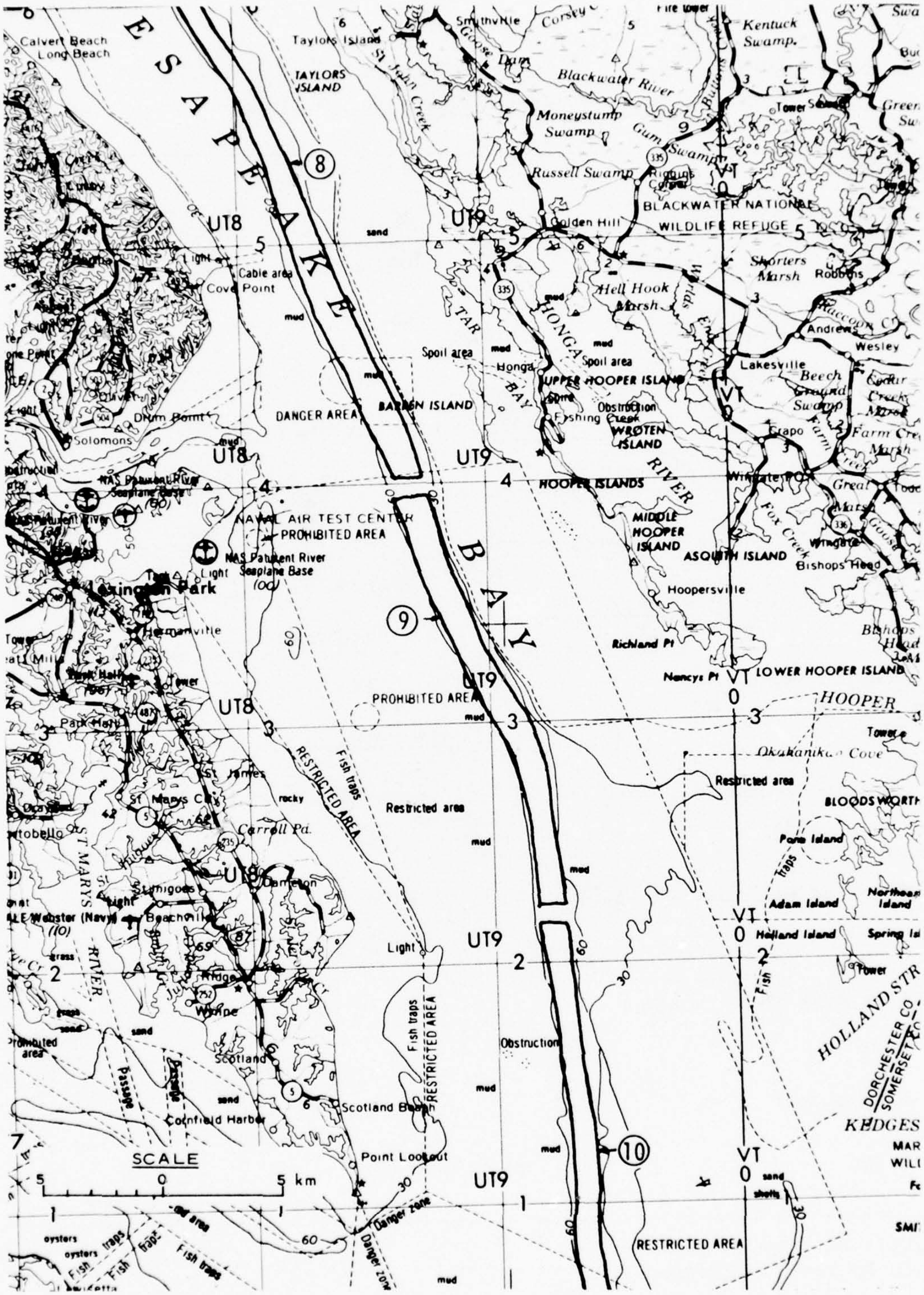


Figure 7. Subaqueous site locations, vicinity of Lexington Park, Maryland

Table 12

Subaqueous Pit, Hole, or Depression Characteristics

Site 8, Vicinity of Lexington Park, Maryland

Location

Geographic Coordinates

North 38° 23' 00"

West 76° 20' 00"

CE District Baltimore

State Maryland

County Calvert, Dorchester

C & G Chart 553

1:250,000 Topographic Map Washington, D. C.

Fig. 7 Site 8

History

NA

Excavation Method

Natural

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 25,000

Width, m NA

Depth, m NA

Area, km^2 34.8

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 16.

Table 13

Subaqueous Pit, Hole, or Depression Characteristics

Site 9, Vicinity of Lexington Park, Maryland

Location	Description
Geographic Coordinates	**Shape**
North 38° 13' 00"	Linear
West 76° 15' 00"	**Size**
CE District Baltimore	Diameter, m NA
State Maryland	Length, m 22,000
County St. Mary's, Dorchester	Width, m NA
C & G Chart 554	Depth, m NA
1:250,000 Topographic Map Washington, D.C.	Area, km^2 16.72
Fig. 7 Site 9	**Bank Angle**
	NA
History	
NA	**Environment**
Excavation Method	**Bed Materials**
Natural	NA
Material Utilization	**Water**
NA	Depth, m NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 16.

Table 14

Subaqueous Pit, Hole, or Depression Characteristics

Site 10, Vicinity of Lexington Park, Maryland

Location

Geographic Coordinates

North 39° 09' 00"

West 76° 14' 00"

CE District Baltimore

State Maryland

County Dorchester,Somerset,St.Mary's

C & G Chart 557

1:250,000 Topographic Map Washington, D.C. - Richmond,Va.

Fig. 7 **Site** 10

History

NA

Excavation Method

Natural

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m NA

Area, km^2 20.06

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 16.

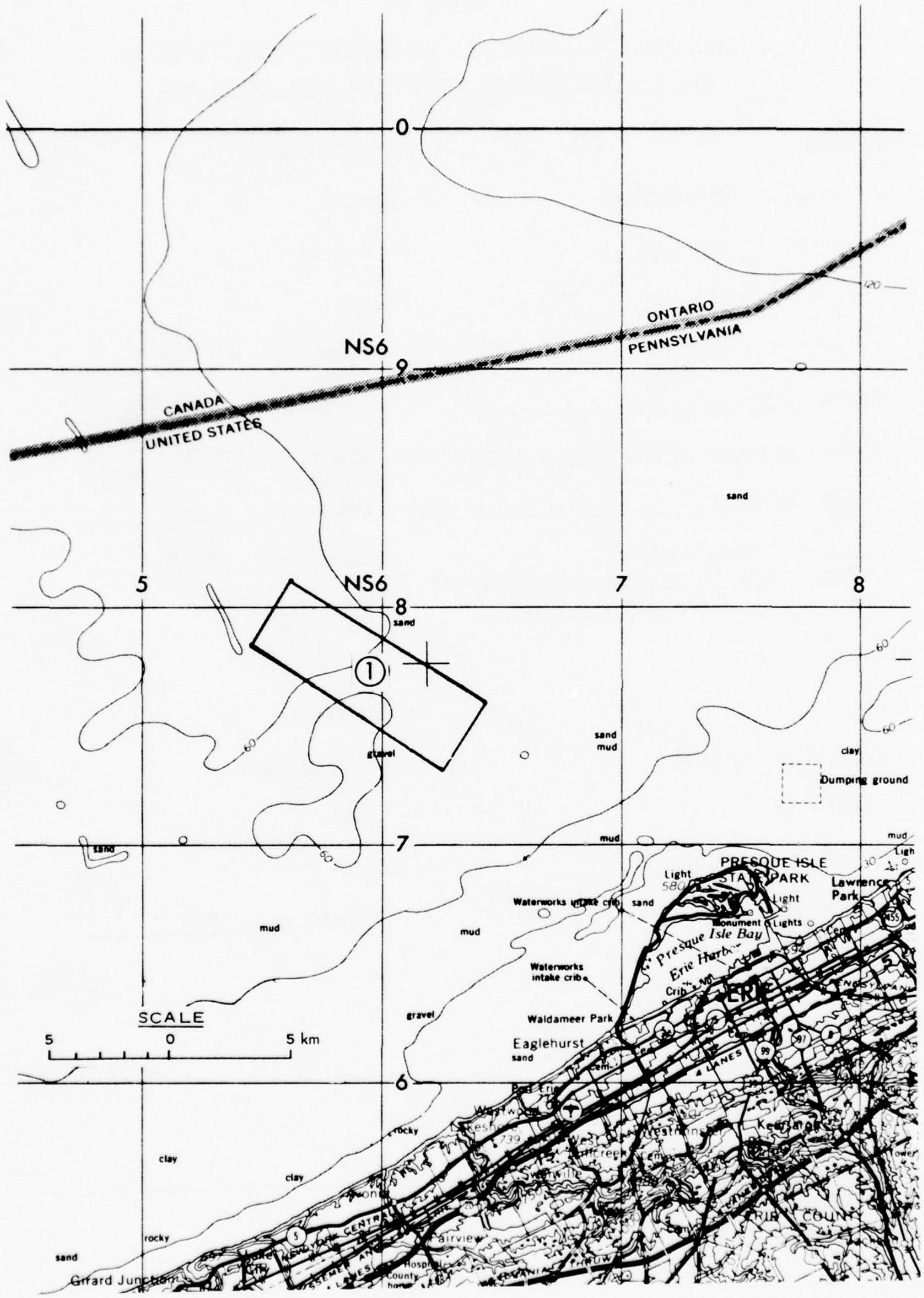


Figure 8. Subaqueous site location, vicinity of Erie, Pennsylvania

Table 15

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Erie, Pennsylvania

Location

Geographic Coordinates

North 42° 15'

West 80° 17'

CE District Buffalo

State Pennsylvania

County NA

C & G Chart NA

1:250,000 Topographic Map Erie

Fig. 8 **Site** 1

History

Ongoing

Excavation Method

Hydraulic

Material Utilization

Fill

Aggregate

Available Data

NA

Alterations

NA

Description

Shape

Rectangular

Size

Diameter, m NA

Length, m 9660

Width, m 3220

Depth, m <1

Area, km^2 31.08

Bank Angle

<20 deg

Environment

Bed Materials

Sand and gravel

Water

Depth, m NA

Note: NA = not available.

Data Source: Reference 47 and Harry K. Goodman, Marine Manager, Erie Sand and Gravel Company, Erie, Pa., personal communication.

Figure 9. Subaqueous site location, vicinity of Cleveland, Ohio

Table 16

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Cleveland, Ohio

Location

Geographic Coordinates

North 41° 48'

West 81° 23'

CE District Buffalo

State Ohio

County NA

C & G Chart NA

1:250,000 Topographic Map Cleveland

Fig. 9 Site 1

History

Ongoing

Excavation Method

Hydraulic

Material Utilization

Fill

Aggregate

Available Data

NA

Alterations

NA

Description

Shape

Rectangular

Size

Diameter, m NA

Length, m 2820

Width, m 1210

Depth, m <1

Area, km^2 3.41

Bank Angle

NA

Environment

Bed Materials

Sand and gravel

Water

Depth, m NA

Note: NA = not available.

Data Source: Reference 47.

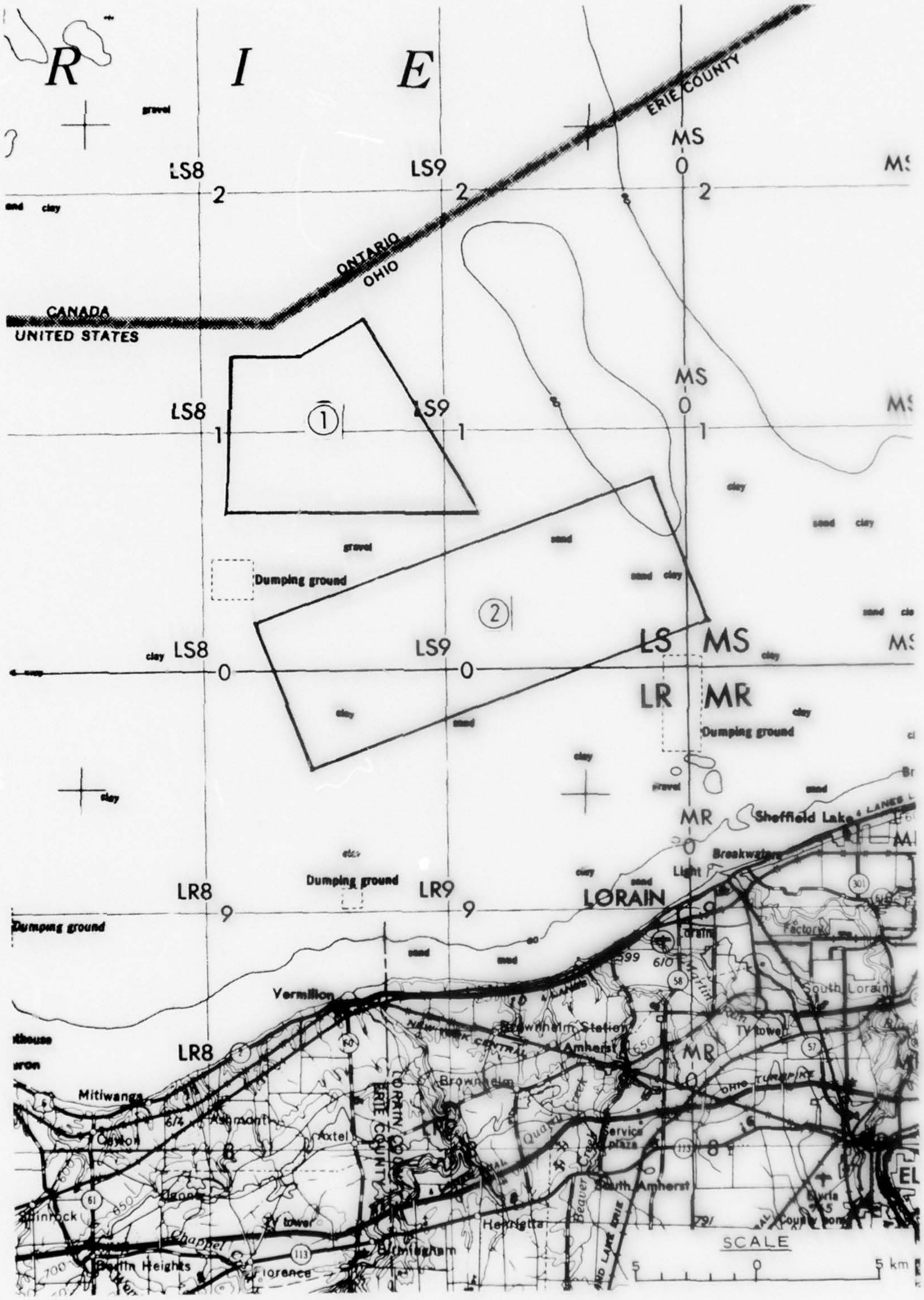


Figure 10. Subaqueous site locations, vicinity of Lorain, Ohio

Table 17

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Lorain, Ohio

Location	Description
Geographic Coordinates	Shape
North 41° 38'	Irregular
West 82° 23'	Size
CE District Buffalo	Diameter, m NA
State Ohio	Length, m 9660
County NA	Width, m 6440
C & G Chart NA	Depth, m <1
1:250,000 Topographic Map Toledo	Area, km^2 6.22
Fig. 10 Site 1	Bank Angle
History	<20 deg
Ongoing	Environment
Excavation Method	Bed Materials
Hydraulic	Sand and gravel
Material Utilization	Water
Fill Aggregate	Depth, m NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 47.

Table 18

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, Vicinity of Lorain, Ohio

Location	Description
Geographic Coordinates	Shape
North 41° 34'	Rectangular
West 82° 18'	Size
CE District Buffalo	Diameter, m NA
State Ohio	Length, m 17,700
County NA	Width, m 6440
C & G Chart NA	Depth, m <1
1:250,000 Topographic Map Toledo	Area, km^2 113.97
Fig. 10 Site 2	Bank Angle
History	<20 deg
Ongoing	Environment
Excavation Method	Bed Materials
Hydraulic	Sand and gravel
Material Utilization	Water
Fill Aggregate	Depth, m NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 47.

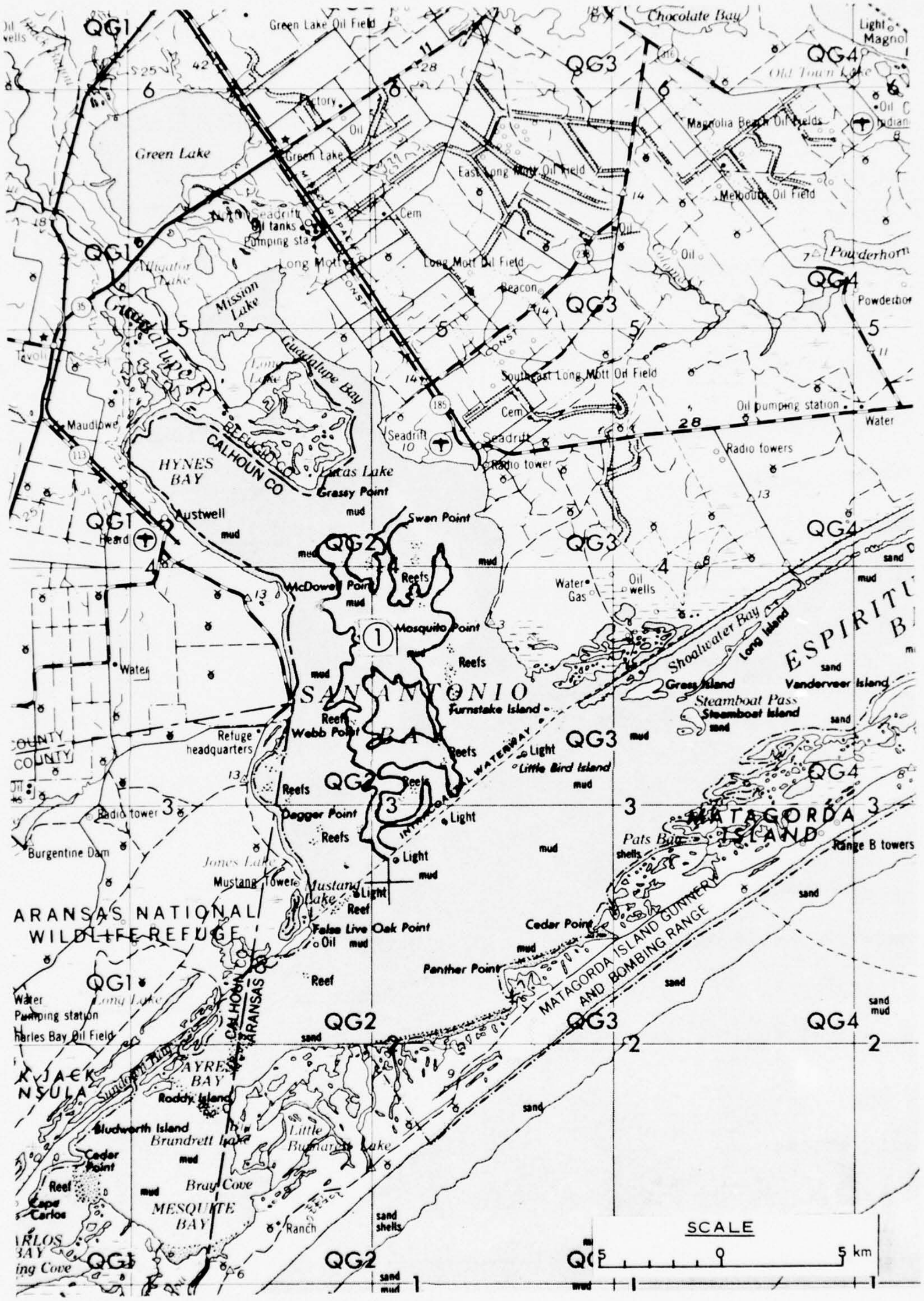


Figure 11. Subaqueous site location, vicinity of San Antonio Bay, Texas

Table 19

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of San Antonio Bay, Texas

Location	Description
Geographic Coordinates	Shape
North 28° 20'	Irregular
West 96° 45'	Size
CE District Galveston	Diameter, m NA
State Texas	Length, m NA
County Calhoun	Width, m NA
C & G Chart 1285	Depth, m 12
1:250,000 Topographic Map Beeville	Area, km^2 25.2 (multiple sites)
Fig. 11 Site 1	Bank Angle
History	NA
Ongoing	Environment
Excavation Method	Bed Materials
Hydraulic	Shell
Material Utilization	Water
Aggregate	Depth, m 0.3 - 2.1
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 5.

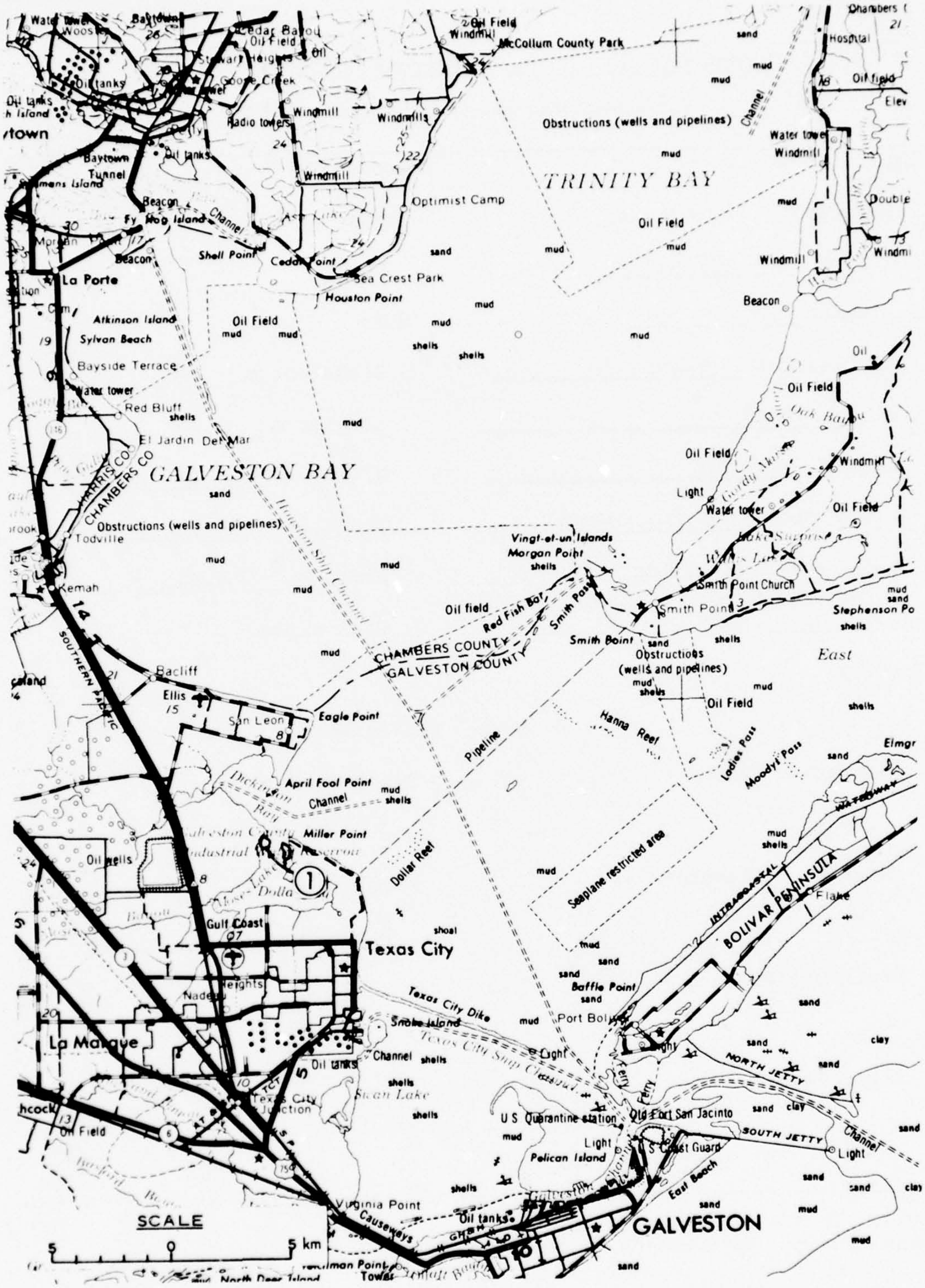


Figure 12. Subaqueous site location, vicinity of Galveston, Texas

Table 20

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Galveston, Texas

Location	Description
Geographic Coordinates	Shape
North 29° 26' 40"	Linear
West 94° 55' 30"	Size
CE District Galveston	Diameter, m NA
State Texas	Length, m NA
County Galveston	Width, m NA
C & G Chart 152-SC, Page B	Depth, m 12
1:250,000 Topographic Map Houston	Area, km^2 0.23
Fig. 12 Site 1	Bank Angle
History	NA
NA	Environment
Excavation Method	Bed Materials
NA	NA
Material Utilization	Water
NA	Depth, m NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 4.

Figure 13. Subaqueous site locations, vicinity of St. Petersburg, Florida

Table 21

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of St. Petersburg, Florida

Location

Geographic Coordinates

North 27° 24'

West 82° 43'

CE District Jacksonville

State Florida

County Manatee

C & G Chart 586

1:250,000 Topographic Map Tampa

Fig. 13 **Site** 1

History

Proposed

Excavation Method

Hydraulic

Material Utilization

Coastal Nourishment
940,000 cu yd

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 5791

Width, m 305

Depth, m 3.0

Area, km² 1.8

Bank Angle

NA

Environment

Bed Materials

Sand and shell

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 48.

Table 22

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, Vicinity of St. Petersburg, Florida

Location

Geographic Coordinates

North 27° 37' 30"

West 82° 44' 45"

CE District Jacksonville

State Florida

County Pinellas

C & G Chart 586

1:250,000 Topographic Map Tampa

Fig. 13 **Site** 2

History

Proposed

Excavation Method

Hydraulic

Material Utilization

Coastal Nourishment
325,000 cu yd

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 1828

Width, m 182.8

Depth, m 6.1

Area, km^2 0.33

Bank Angle

NA

Environment

Bed Materials

Sand and shell

Water

Depth, m 2.1 - 2.7

Note: NA = not available.
Data Source: Reference 49.

Table 23

Subaqueous Pit, Hole, or Depression Characteristics

Site 3, Vicinity of St. Petersburg, Florida

Location	Description
Geographic Coordinates	Shape
North 27° 45' 30"	NA
West 82° 46' 00"	Size
CE District Jacksonville	Diameter, m NA
State Florida	Length, m 3000
County Pinellas	Width, m 200
C & G Chart 1257	Depth, m 7
1:250,000 Topographic Map Tampa	Area, km^2 NA
Fig. 13 Site 3	Bank Angle
History	NA
Completed July 1969	Environment
Excavation Method	Bed Materials
Hydraulic	Sand
Material Utilization	Water
Coastal Nourishment 693,000 cu yd	Depth, m 4
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 18.

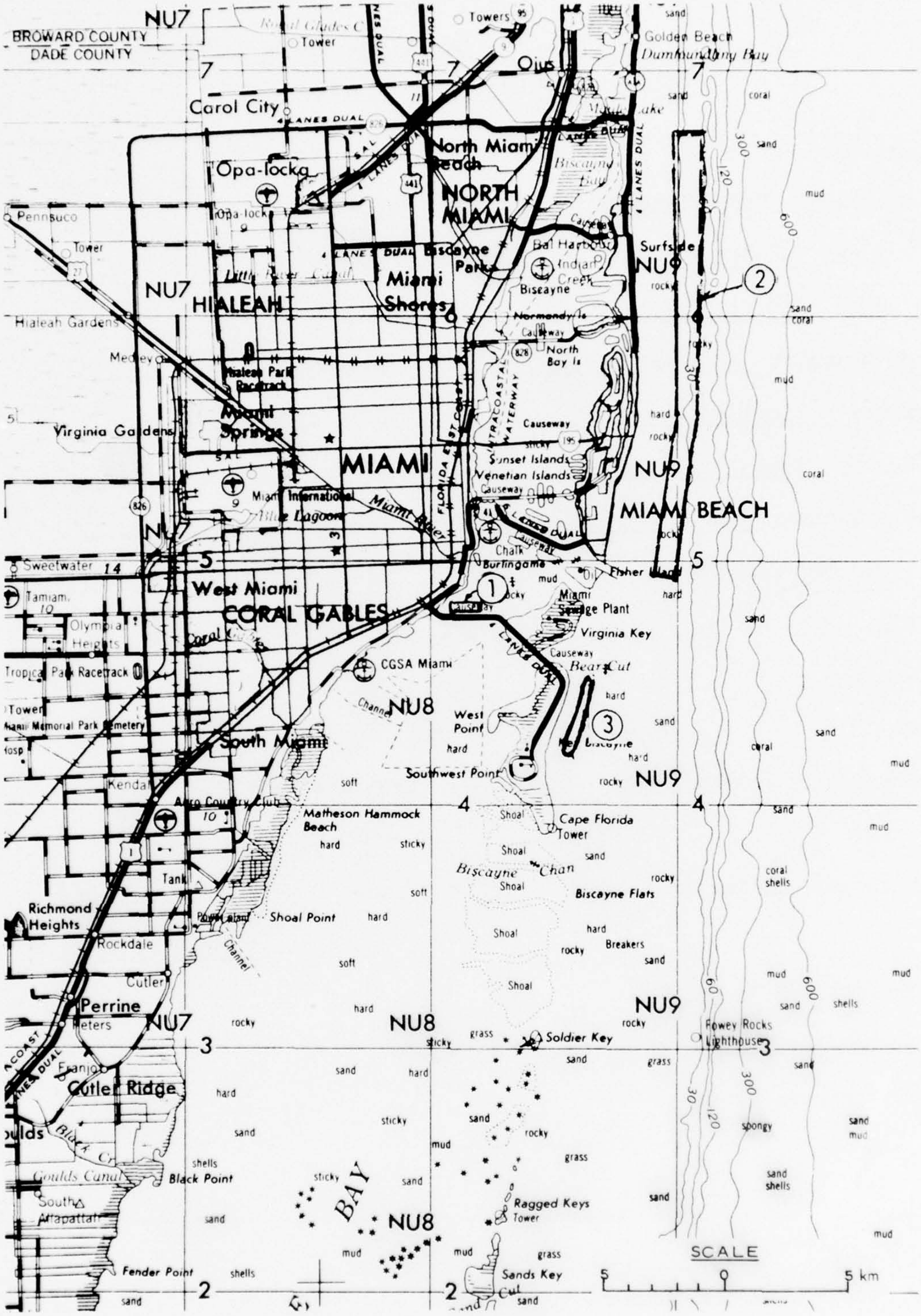


Figure 14. Subaqueous site locations, vicinity of Miami, Florida

Table 24

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Miami, Florida

Location	Description
Geographic Coordinates	Shape
North 25° 44' 53"	Linear
West 80° 11' 35"	Size
CE District Jacksonville	Diameter, m NA
State Florida	Length, m 1234
County Dade	Width, m 183
C & G Chart 848	Depth, m NA
1:250,000 Topographic Map Miami	Area, km^2 0.226
Fig. 14 Site 1	Bank Angle
	NA
History	
NA	Environment
Excavation Method	Bed Materials
NA	Sand
Material Utilization	Water
Fill	Depth, m NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 50.

Table 25

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, Vicinity of Miami, Florida

Location

Geographic Coordinates

North 25° 55' 25" to 25° 45' 30"

West 80° 06' 00" to 80° 06' 45"

CE District Jacksonville

State Florida

County Dade

C & G Chart 847-SC, 1248

1:250,000 Topographic Map Miami

Fig. 14 **Site** 2

History

Proposed (FY 76)

Excavation Method

Hydraulic

Material Utilization

Coastal Nourishment

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 18

Width, m 914

Depth, m NA

Area, km^2 16.5

Bank Angle

NA

Environment

Bed Materials

Sand

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 51.

Table 26

Subaqueous Pit, Hole, or Depression Characteristics

Site 3, Vicinity of Miami, Florida

Location

Geographic Coordinates

North 25° 42' 30"

West 80° 08' 30"

CE District Jacksonville

State Florida

County Dade

C & G Chart 847-SC, 848

1:250,000 Topographic Map Miami

Fig. 14 Site 3

History

Initiated 1969
Completed 1969

Excavation Method

Hydraulic

Material Utilization

Coastal Nourishment
373,000 cu yd

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 2720

Width, m 152

Depth, m NA

Area, km^2 0.413

Bank Angle

NA

Environment

Bed Materials

Sand and shell

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 52.

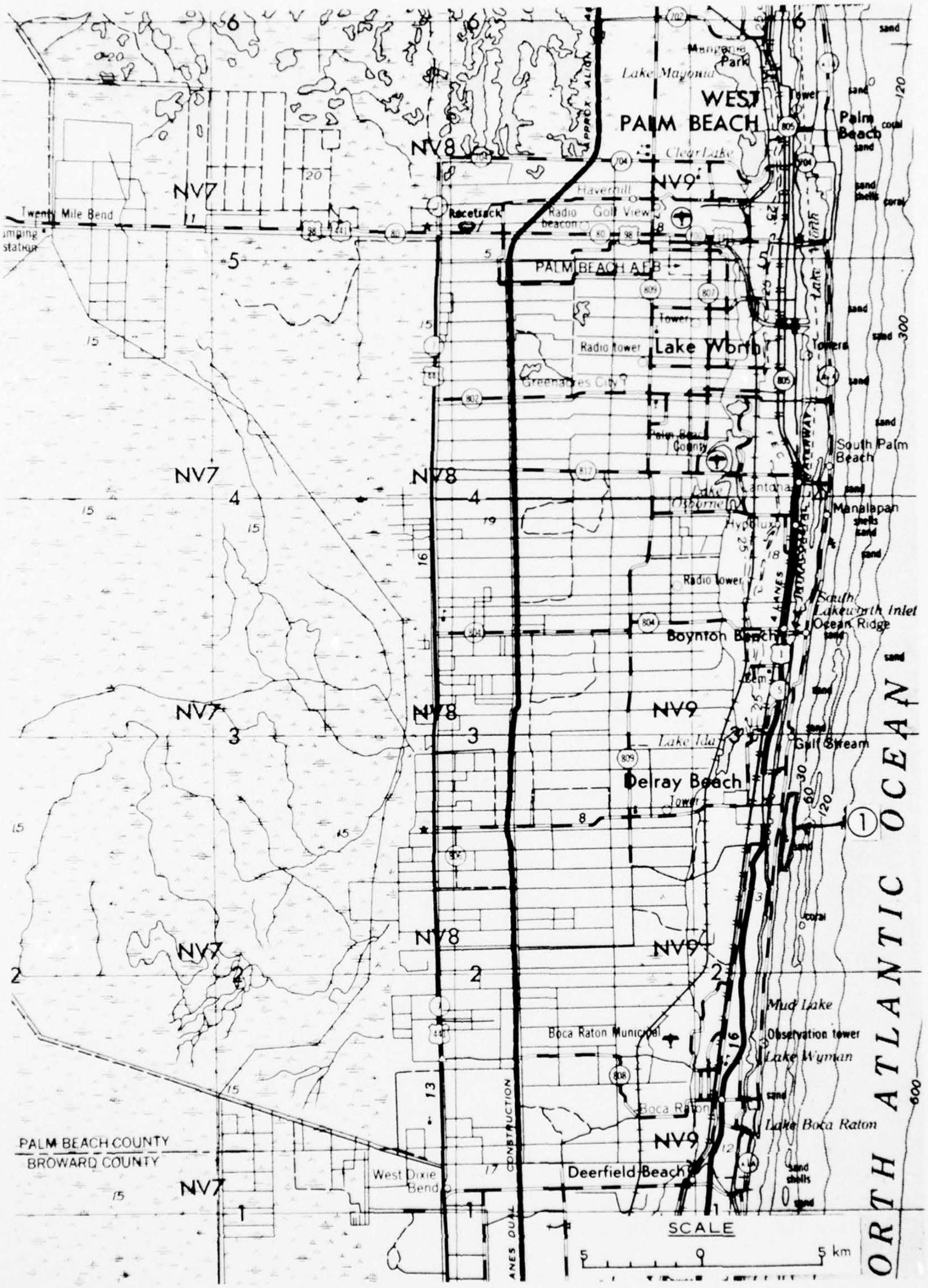


Figure 15. Subaqueous site location, vicinity of Delray Beach, Florida

Table 27

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Delray Beach, Florida

Location

Geographic Coordinates

North 26° 27' 00"

West 80° 03' 30"

CE District Jacksonville

State Florida

County Palm Beach

C & G Chart NA

1:250,000 Topographic Map West Palm Beach

Fig. 15 **Site** 1

History

Proposed

Excavation Method

Hydraulic

Material Utilization

Coastal Nourishment
1,000,000 cu yd

Available Data

Biological

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 2743

Width, m 488

Depth, m NA

Area, km² 1.3

Bank Angle

NA

Environment

Bed Materials

Sand

Water

Depth, m 7.6 to 18.3

Note: NA = not available.
Data Source: Reference 53.

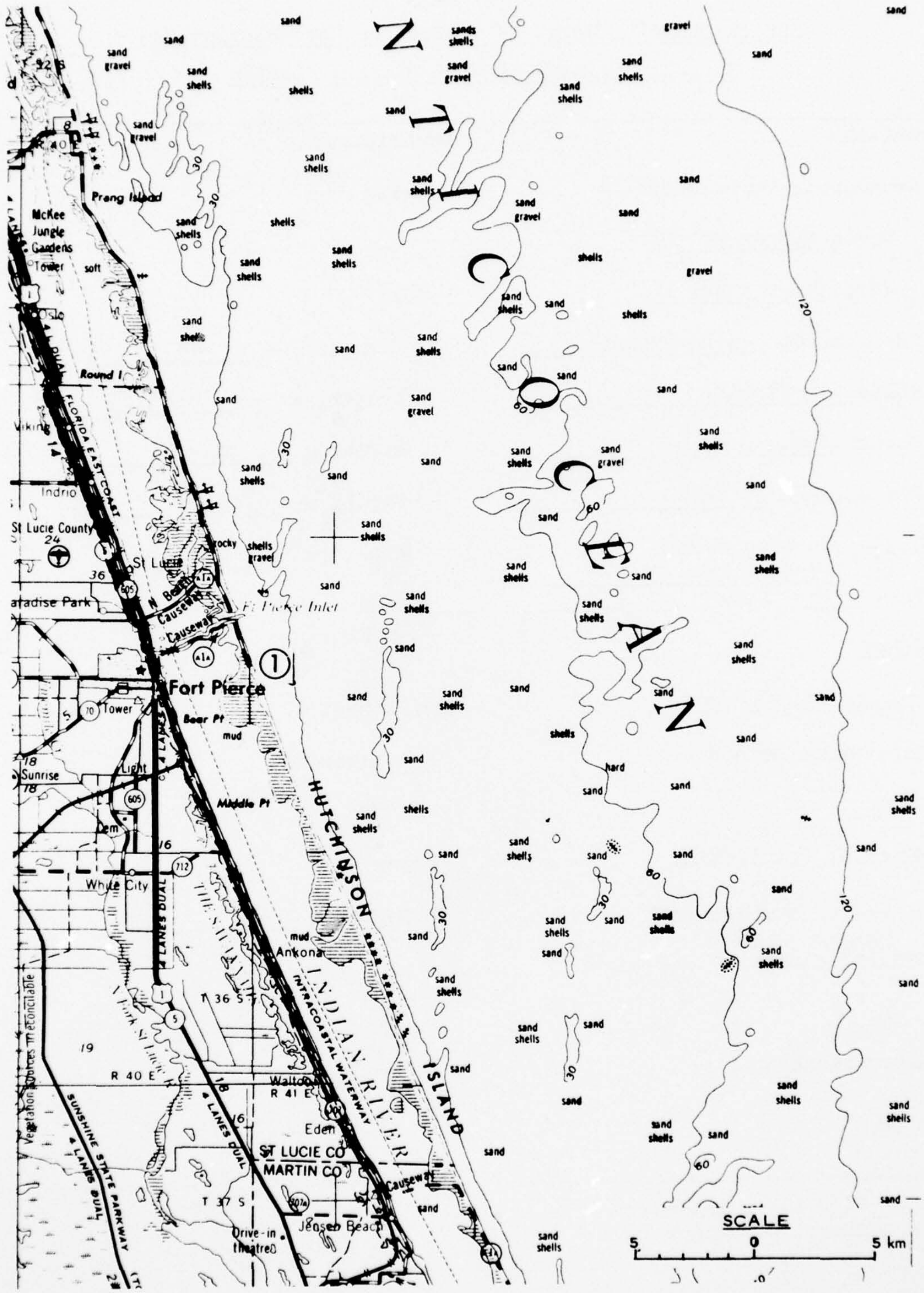


Figure 16. Subaqueous site location, vicinity of Fort Pierce, Florida

Table 28

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Fort Pierce, Florida

Location

Geographic Coordinates

North Approx 27° 27'

West Approx 80° 17'

CE District Jacksonville

State Florida

County St. Lucie

C & G Chart 845-SC

1:250,000 Topographic Map Fort Pierce

Fig. 16 Site 1

History

Completed July 1971

Excavation Method

NA

Material Utilization

Coastal Nourishment
700,000 cu yd

Available Data

NA

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m 2100

Width, m NA

Depth, m NA

Area, km^2 NA

Bank Angle

NA

Environment

Bed Materials

Sand

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 18.

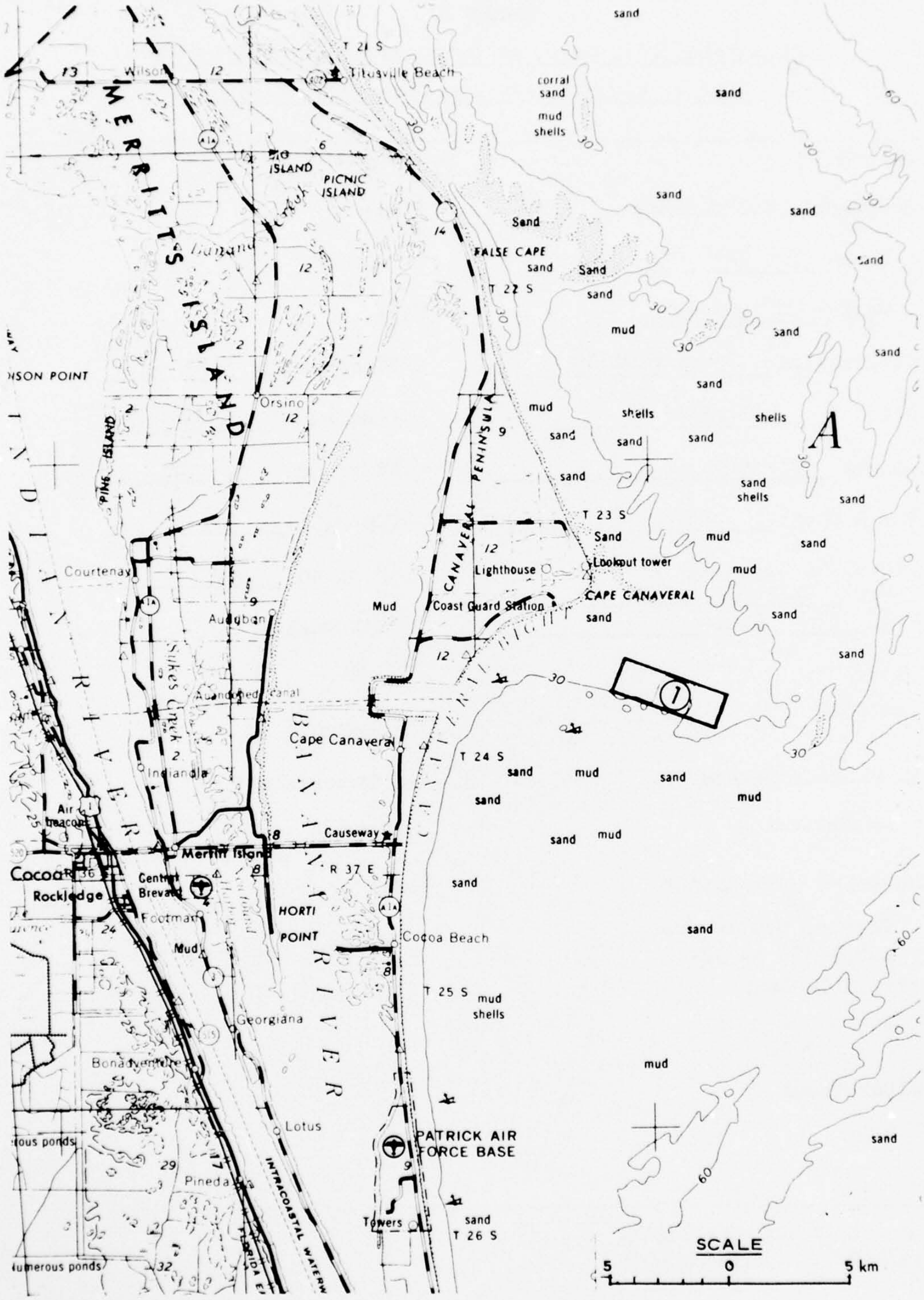


Figure 17. Subaqueous site location, vicinity of Cape Canaveral, Florida

Table 29

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Cape Canaveral, Florida

Location

Geographic Coordinates

North 28° 24' 45"

West 80° 30' 00"

CE District Jacksonville

State Florida

County Brevard

C & G Chart 1245

1:250,000 Topographic Map Orlando

Fig. 17 **Site** 1

History

Proposed

Excavation Method

Mechanical

Material Utilization

Coastal Nourishment
1,591,000 cu yd

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 5600

Width, m 1600

Depth, m NA

Area, km^2 9.0

Bank Angle

NA

Environment

Bed Materials

Sand

Water

Depth, m 4.9 - 9.1

Note: NA = not available.
Data Source: Reference 54.

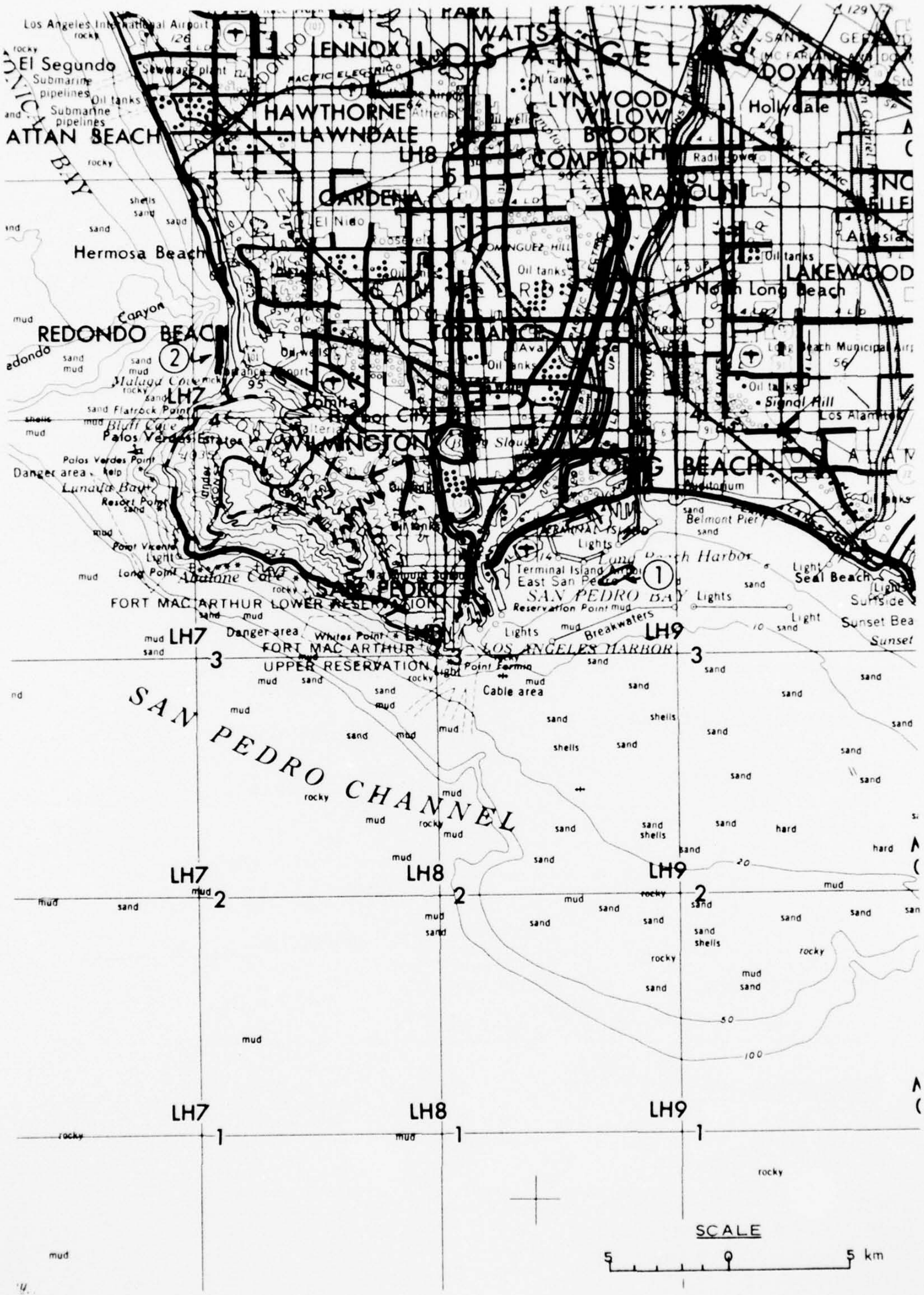


Figure 18. Subaqueous site locations, vicinity of Los Angeles, California

Table 30

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Los Angeles, California

Location	Description
Geographic Coordinates	Shape
North 33° 40'	NA
West 118° 10' (Approximate)	Size
CE District Los Angeles	Diameter, m NA
State California	Length, m NA
County Los Angeles	Width, m NA
C & G Chart 5148	Depth, m NA
1:250,000 Topographic Map Long Beach	Area, km^2 NA
Fig. 18 Site 1	Bank Angle
History	NA
Initiated September 1965	Environment
Excavation Method	Bed Materials
Hydraulic	NA
Material Utilization	Water
Fill	Depth, m NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 27.

Table 31

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, Vicinity of Los Angeles, California

Location	Description
Geographic Coordinates	**Shape**
North 33° 44' 15"	Linear
West 118° 23' 35"	**Size**
CE District Los Angeles	**Diameter, m** NA
State California	**Length, m** 1950
County Los Angeles	**Width, m** 182
C & G Chart 5144	**Depth, m** 6.1
1:250,000 Topographic Map Long Beach	**Area, km^2** 0.35
Fig. 18 **Site** 2	**Bank Angle**
History	NA
Initiated December 1967 Completed October 1968	**Environment**
Excavation Method	**Bed Materials**
Hydraulic	Sand
Material Utilization	**Water**
Coastal Nourishment 1,406,000 cu yd	**Depth, m** 9.1 - 12.2
Available Data	
Physical	
Alterations	
May 1973 hydrographic survey shows little refilling of pit	

Note: NA = not available.
Data Source: Reference 55.

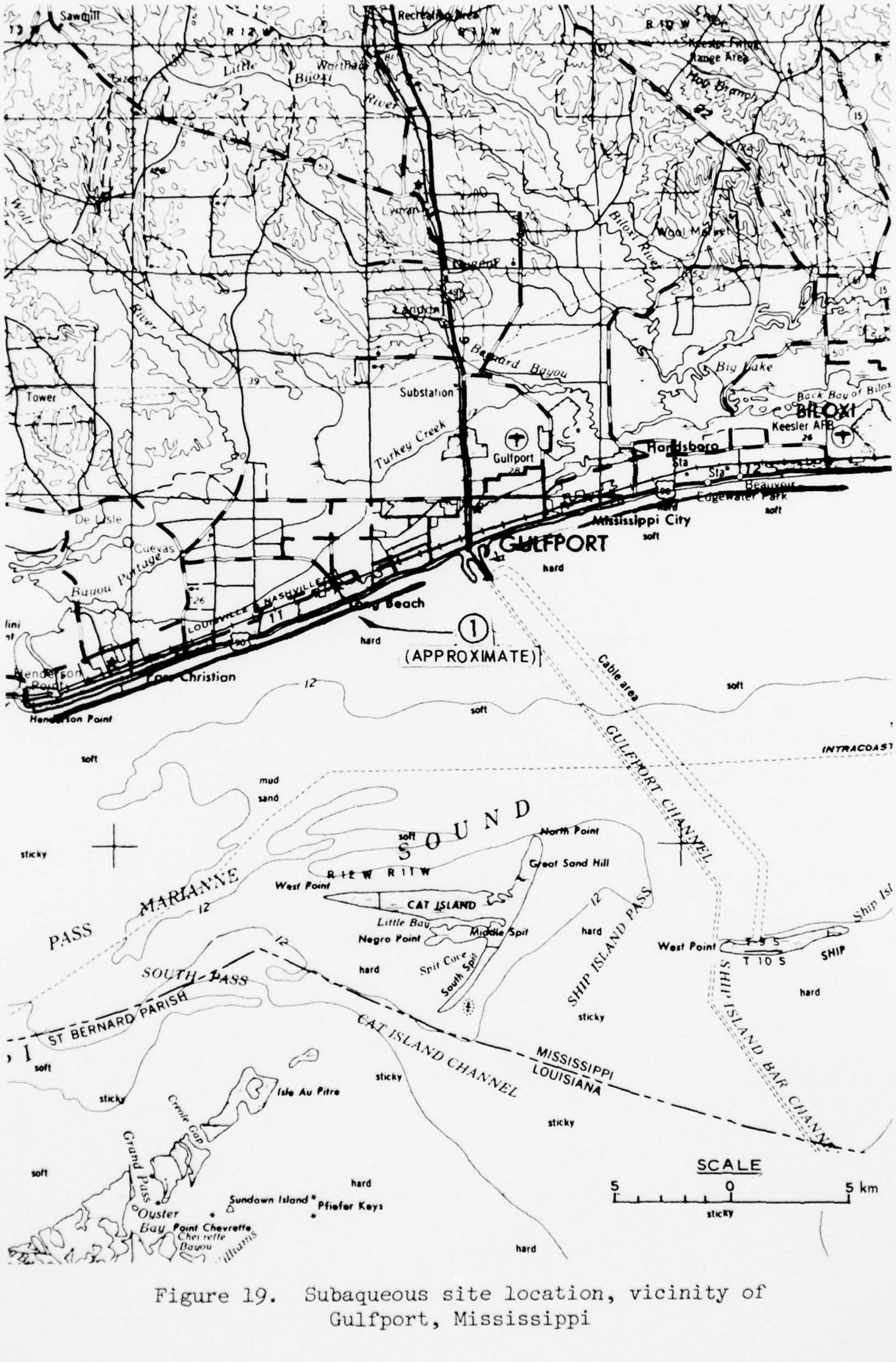


Figure 19. Subaqueous site location, vicinity of Gulfport, Mississippi

Table 32

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Gulfport, Mississippi

Location

Geographic Coordinates

North 30° 13' 00" to 30° 23' 15"

West 89° 16' 40" to 88° 55' 30"

CE District Mobile

State Mississippi

County Harrison

C & G Chart 876-SC, 1267, 1268

1:250,000 Topographic Map Mobile

Fig. 19 **Site** 1

History

Initiated January 1951
Completed November 1951

Excavation Method

Hydraulic

Material Utilization

Coastal Nourishment
5,985,000 cu yd

Available Data

Physical

Alterations

Yes

Description

Shape

Linear

Size

Diameter, m NA

Length, m 0306

Width, m 600

Depth, m 3

Area, km^2 1.8

Bank Angle

NA

Environment

Bed Materials

Sand

Water

Depth, m 0.6 - 1.2

Note: NA = not available.
Data Source: References 19, 20.

Figure 20. Subaqueous site locations, vicinity of New Haven, Connecticut

AD-A043 052 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 13/2
INVESTIGATION OF SUBAQUEOUS BORROW PITS AS POTENTIAL SITES FOR --ETC(U)
MAY 77 J D BROUGHTON

UNCLASSIFIED WES-TR-D-77-5 NL

2 OF 3
AD
A043052

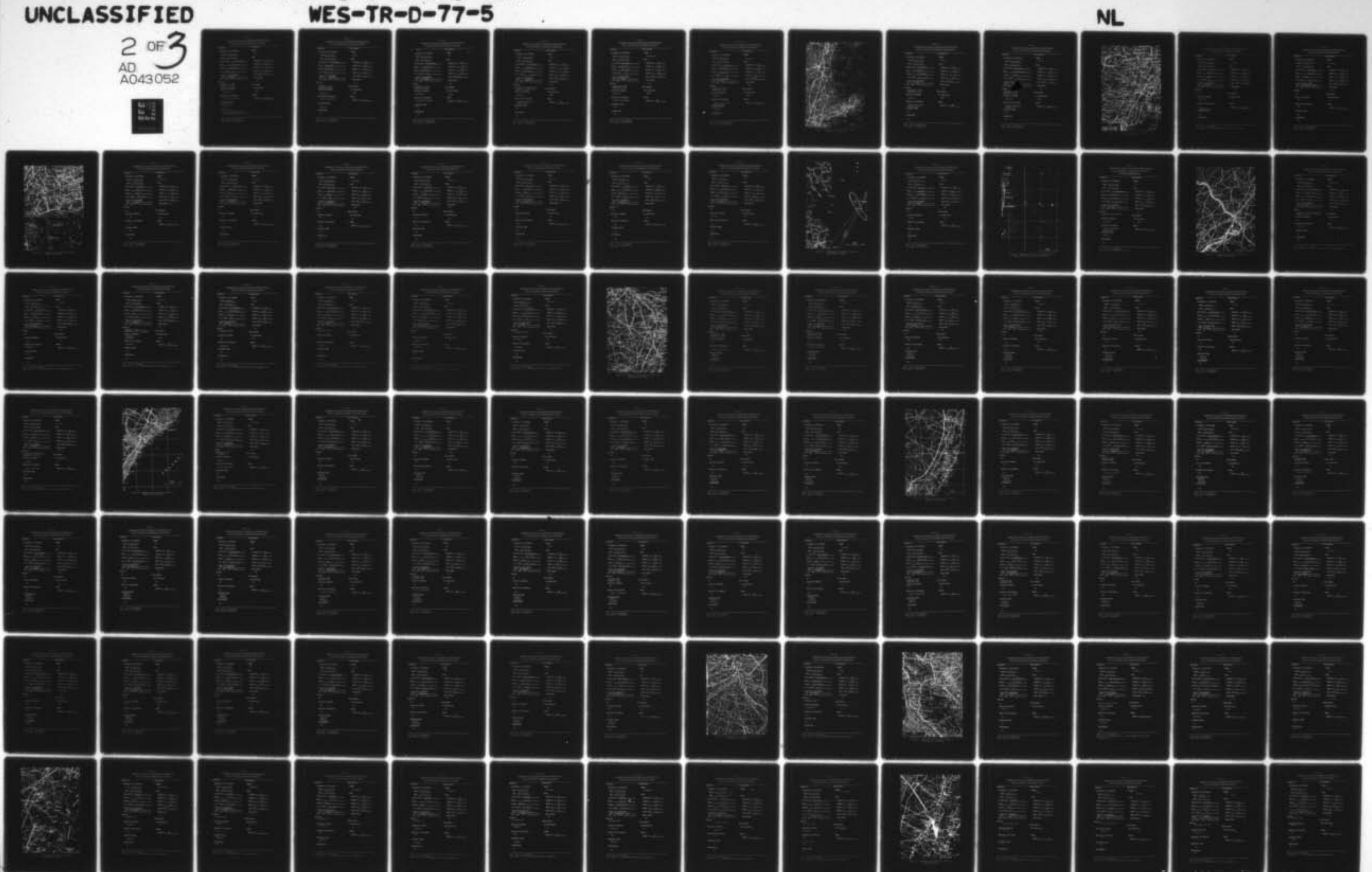


Table 33

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of New Haven, Connecticut

Location

Geographic Coordinates

North 41° 14' 35"

West 72° 57' 45"

CE District New England

State Connecticut

County New Haven

C & G Chart 218

1:250,000 Topographic Map Hartford

Fig. 20 **Site** 1

History

Initiated in 1957
Completed in 1957

Excavation Method

Hydraulic

Material Utilization

Coastal Nourishment

Available Data

Physical

Alterations

Natural refilling of pit is occurring slowly (8000 yd/yr)

Description

Shape

Linear

Size

Diameter, m NA

Length, m 549

Width, m 137

Depth, m 8.5

Area, km^2 0.08

Bank Angle

NA

Environment

Bed Materials

Sand

Water

Depth, m 1.5 - 3.7

Note: NA = *not available.*
Data Source: Reference 22.

Table 34

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, Vicinity of New Haven, Connecticut

Location	Description
Geographic Coordinates	**Shape**
North 41° 09' 05"	Linear
West 73° 12' 00"	**Size**
CE District New England	Diameter, m NA
State Connecticut	Length, m 1128
County Fairfield	Width, m 107
C & G Chart 220	Depth, m 5.2
1:250,000 Topographic Map Hartford	Area, km^2 0.12
Fig. 20 Site 2	**Bank Angle**
History	NA
Initated in 1957 Completed in 1957	**Environment**
Excavation Method	**Bed Materials**
Hydraulic	Sand
Material Utilization	**Water**
Coastal Nourishment	Depth, m 2 - 3
Available Data	
Physical	
Alterations	
Yes	

Note: NA = not available.
Data Source: Reference 23.

Table 35

Subaqueous Pit, Hole, or Depression Characteristics

Site 3, Vicinity of New Haven, Connecticut

Location	Description
Geographic Coordinates	**Shape**
North 41° 14' 20"	NA
West 72° 53' 15"	**Size**
CE District New England	Diameter, m NA
State Connecticut	Length, m 335
County New Haven	Width, m 183
C & G Chart 218	Depth, m NA
1:250,000 Topographic Map Hartford	Area, km^2 0.06
Fig. 20 Site 3	**Bank Angle**
History	NA
Initiated in 1957 Completed in 1957	**Environment**
Excavation Method	**Bed Materials**
Hydraulic	Sand
Material Utilization	**Water**
Coastal Nourishment	Depth, m NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 56.

Table 36

Subaqueous Pit, Hole, or Depression Characteristics

Site 4, Vicinity of New Haven, Connecticut

Location

Geographic Coordinates

North 41° 13' 05"

West 72° 59' 15"

CE District New England

State Connecticut

County New Haven

C & G Chart 219

1:250,000 Topographic Map Hartford

Fig. 20 Site 4

History

Initiated in November 1958
Completed in April 1959

Excavation Method

Hydraulic

Material Utilization

Coastal Nourishment
256,000 cu yd

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 579

Width, m 152

Depth, m NA

Area, km^2 0.09

Bank Angle

NA

Environment

Bed Materials

Sand

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 56.

Table 37

Subaqueous Pit, Hole, or Depression Characteristics

Site 5, Vicinity of New Haven, Connecticut

Location	Description
Geographic Coordinates	**Shape**
North 41° 12' 20"	Rectangular
West 73° 03' 00"	**Size**
CE District New England	**Diameter, m** NA
State Connecticut	**Length, m** 183
County New Haven	**Width, m** 76
C & G Chart 219	**Depth, m** NA
1:250,000 Topographic Map Hartford	**Area, km^2** 0.01
Fig. 20 **Site** 5	**Bank Angle**
History	NA
Initiated in 1957 Completed in 1957	**Environment**
Excavation Method	**Bed Materials**
Hydraulic	Sand
Material Utilization	**Water**
Coastal Nourishment	**Depth, m** NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 56.

Table 38

Subaqueous Pit, Hole, or Depression Characteristics

Site 6, Vicinity of New Haven, Connecticut

Location	Description
Geographic Coordinates	**Shape**
North 41° 06' 25"	Irregular
West 73° 19' 30"	**Size**
CE District New England	**Diameter, m** NA
State Connecticut	**Length, m** NA
County Fairfield	**Width, m** NA
C & G Chart 221	**Depth, m** 6.7
1:250,000 Topographic Map Hartford	**Area, km²** 0.09
Fig. 20 **Site** 6	**Bank Angle**
History	NA
Initiated in 1957 Completed in 1957	**Environment**
Excavation Method	**Bed Materials**
Hydraulic	Sand
Material Utilization	**Water**
Coastal Nourishment 557,200 cu yd	**Depth, m** 7.6
Available Data	
Physical	
Alterations	
Yes	

Note: NA = not available.
Data Source: Reference 24.

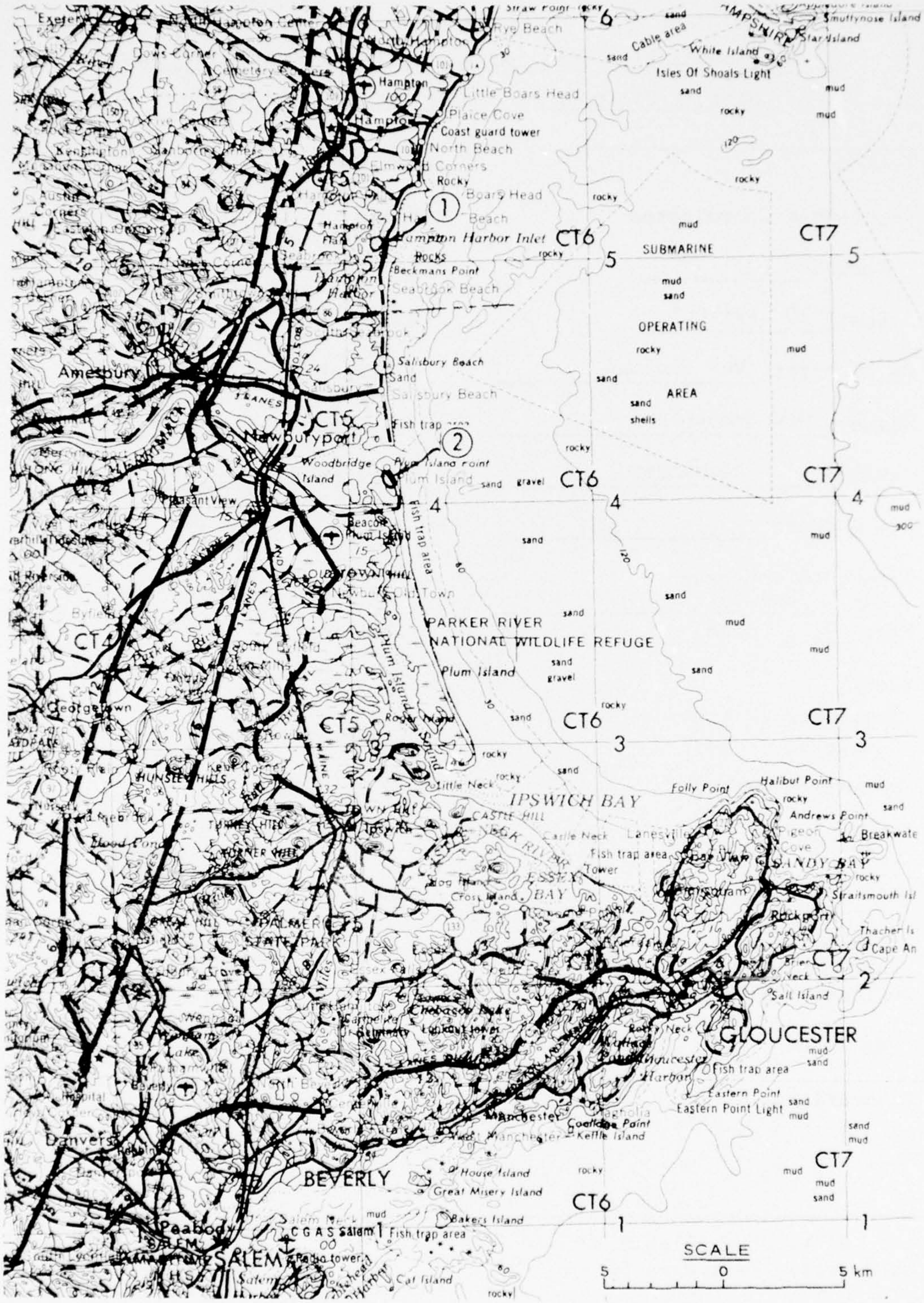


Figure 21. Subaqueous site locations, vicinity of Gloucester, Massachusetts

Table 39

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Gloucester, Massachusetts

Location	Description
Geographic Coordinates	Shape
North 42° 53' 50"	Linear
West 70° 49' 00"	Size
CE District New England	Diameter, m NA
State New Hampshire	Length, m 366
County Rockingham	Width, m 91
C & G Chart 613-SC, 1206	Depth, m NA
1:250,000 Topographic Map Boston	Area, km^2 0.03
Fig. 21 Site 1	Bank Angle
History	NA
Initiated in 1955 Completed in 1955	Environment
Excavation Method	Bed Materials
Hydraulic	Sand
Material Utilization	Water
Coastal Nourishment 400,000 cu yd	Depth, m NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 56.

Table 40

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, Vicinity of Gloucester, Massachusetts

Location

Geographic Coordinates

North 42° 48' 30"

West 70° 49' 00"

CE District New England

State Massachusetts

County Essex

C & G Chart 213

1:250,000 Topographic Map Boston

Fig. 21 [illegible] 2

History

Initiated in 1953
Completed in 1953

Excavation Method

Hydraulic

Material Utilization

Coastal Nourishment
560,000 cu yd

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 640

Width, m 152

Depth, m NA

Area, km^2 0.1

Bank Angle

NA

Environment

Bed Materials

Sand

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 56.

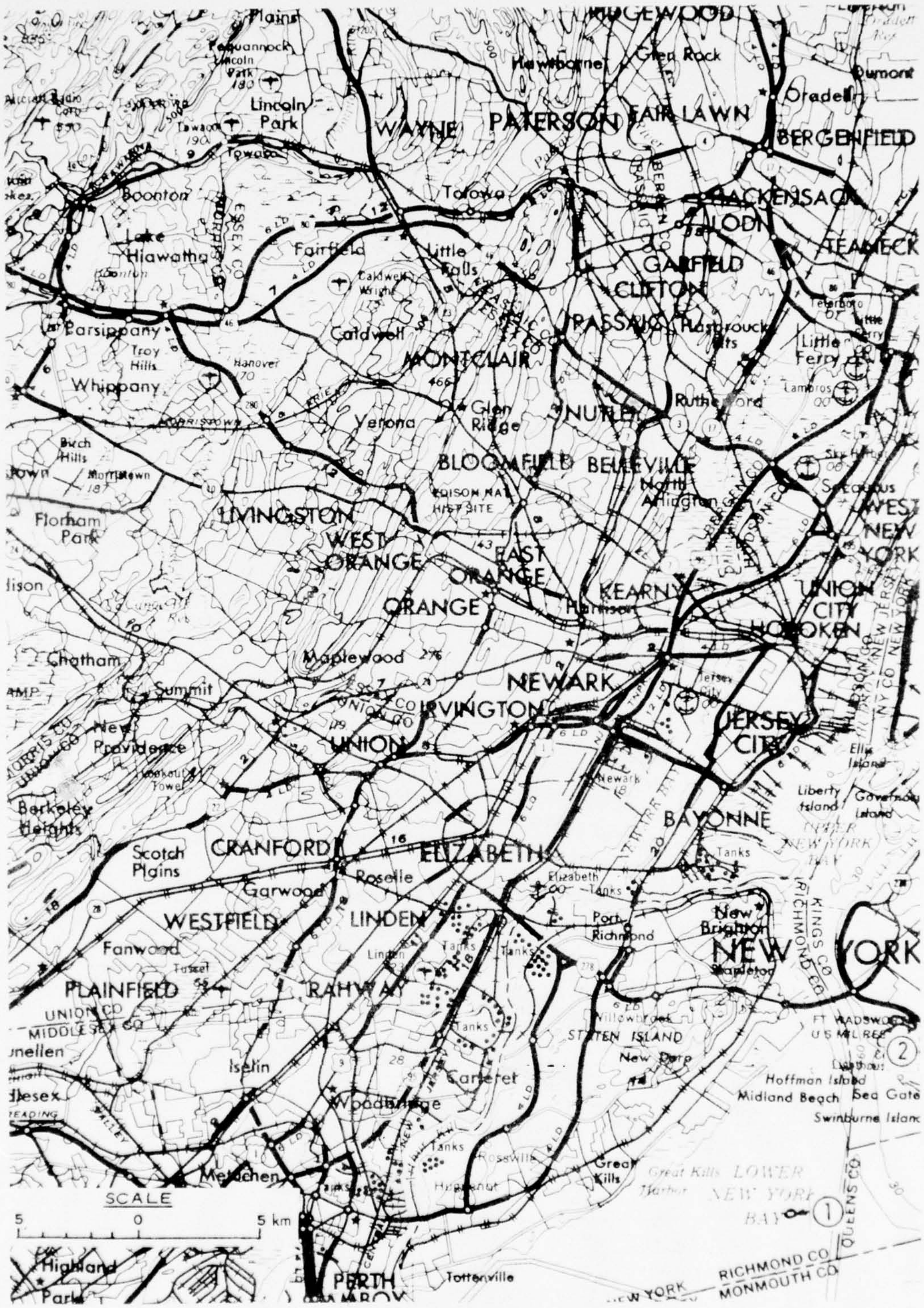


Figure 22. Subaqueous site locations, Lower New York Bay, New York

Table 41

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Lower New York Bay, New York

Location

Geographic Coordinates

North 40° 31' 19"

West 74° 02' 59"

CE District New York

State New York

County Richmond

C & G Chart 369

1:250,000 Topographic Map Newark

Fig. 22 Site 1

History

NA

Excavation Method

Hydraulic

Material Utilization

Fill
6,000,000 cu yd

Available Data

NA

Alterations

NA

Description

Shape

Circular

Size

Diameter, m NA

Length, m 610

Width, m 518

Depth, m 19.5

Area, km^2 0.316

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m 6 -24

Note: NA = not available.
Data Source: U. S. Army Engineer District, New York, CE.

Table 42

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, Lower New York Bay, New York

Location

Geographic Coordinates

North 40° 35' to 36'

West 74° 00' to 01'

CE District New York

State New York

County Kings

C & G Chart 540, 369

1:250,000 Topographic Map Newark, Long Island

Fig. 22 Site 2

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 12.5

Area, km^2 NA

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m 4

Note: NA = not available.
Data Source: Reference 57.

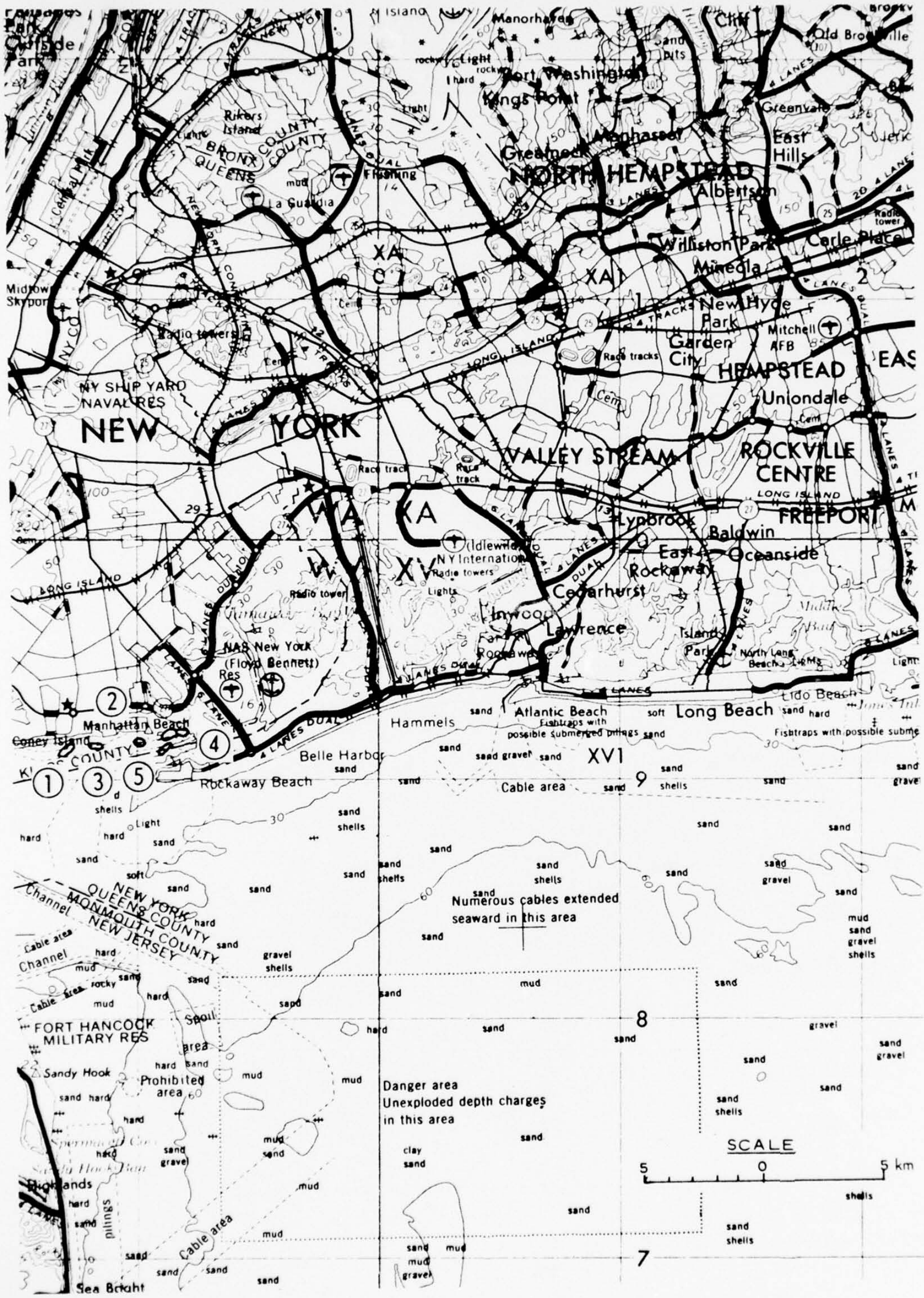


Figure 23. Subaqueous site locations, vicinity of New York, New York

Table 43

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of New York, New York

Location

Geographic Coordinates

North 40° 34' 10"

West 73° 58' 20"

CE District New York

State New York

County Kings

C & G Chart 540, 369

1:250,000 Topographic Map New York

Fig. 23 Site 1

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m 740

Width, m 150

Depth, m 12

Area, km^2 0.11

Bank Angle 8m

Environment

Bed Materials

NA

Water

Depth, m 4

Note: NA = not available.
Data Source: Reference 57.

Table 44

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, Vicinity of New York, New York

Location

Geographic Coordinates

North 40° 34' 25"

West 73° 56' 30"

CE District New York

State New York

County Kings

C & G Chart 369

1:250,000 Topographic Map New York

Fig. 23 **Site** 2

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m 330

Width, m 180

Depth, m 10

Area, km² 0.06

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m 3

Note: NA = not available.
Data Source: Reference 57.

Table 45

Subaqueous Pit, Hole, or Depression Characteristics

Site 3, Vicinity of New York, New York

Location

Geographic Coordinates

North 40° 34' 20"

West 73° 57' 30"

CE District New York

State New York

County Kings

C & G Chart 369

1:250,000 Topographic Map New York

Fig. 23 **Site** 3

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m 930

Width, m 190

Depth, m 11

Area, km^2 0.18

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m 4

Note: NA = not available.

Data Source: Reference 57.

Table 46

Subaqueous Pit, Hole, or Depression Characteristics

Site 4, Vicinity of New York, New York

Location

Geographic Coordinates

North 40° 34' 25"

West 73° 55' 25"

CE District New York

State New York

County Kings

C & G Chart 369

1:250,000 Topographic Map New York

Fig. 23 Site 4

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m 930

Width, m 280

Depth, m 11

Area, km^2 NA

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m 4

Note: NA = not available.
Data Source: Reference 57.

Table 47

Subaqueous Pit, Hole, or Depression Characteristics

Site 5, Vicinity of New York, New York

Location

Geographic Coordinates

North 40° 34' 10"

West 73° 55' 45"

CE District New York

State New York

County Kings

C & G Chart 369

1:250,000 Topographic Map New York

Fig. 23 Site 5

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m 650

Width, m 130

Depth, m 10

Area, km^2 0.08

Bank Angle NA

Environment

Bed Materials

NA

Water

Depth, m 5

Note: NA = not available.
Data Source: Reference 57.

Table 48

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, U. S. Army Engineer District, Norfolk

Location

Geographic Coordinates

North 37° 47'

West 75° 58'

CE District Norfolk

State Virginia

County Somerset

C & G Chart 568

1:250,000 Topographic Map Eastville

Fig. 4 Site 2

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 6500

Width, m 13

Depth, m 37

Area, km^2 8.4

Bank Angle

Environment

Bed Materials

NA

Water

Depth, m 14

Note: NA = not available.
Data Source: Reference 58.

Table 49

Subaqueous Pit, Hole, or Depression Characteristics

Site 3, U. S. Army Engineer District, Norfolk

Location	Description
Geographic Coordinates	Shape
North 37° 48'	NA
West 75° 51'	Size
CE District Norfolk	Diameter, m NA
State Virginia	Length, m 92
County Somerset	Width, m 9
C & G Chart 568	Depth, m 24.4
1:250,000 Topographic Map Eastville	Area, km^2 8.5
Fig. 4 Site 3	Bank Angle
History	
NA	Environment
Excavation Method	Bed Materials
Natural	NA
Material Utilization	Water
NA	Depth, m NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 58.

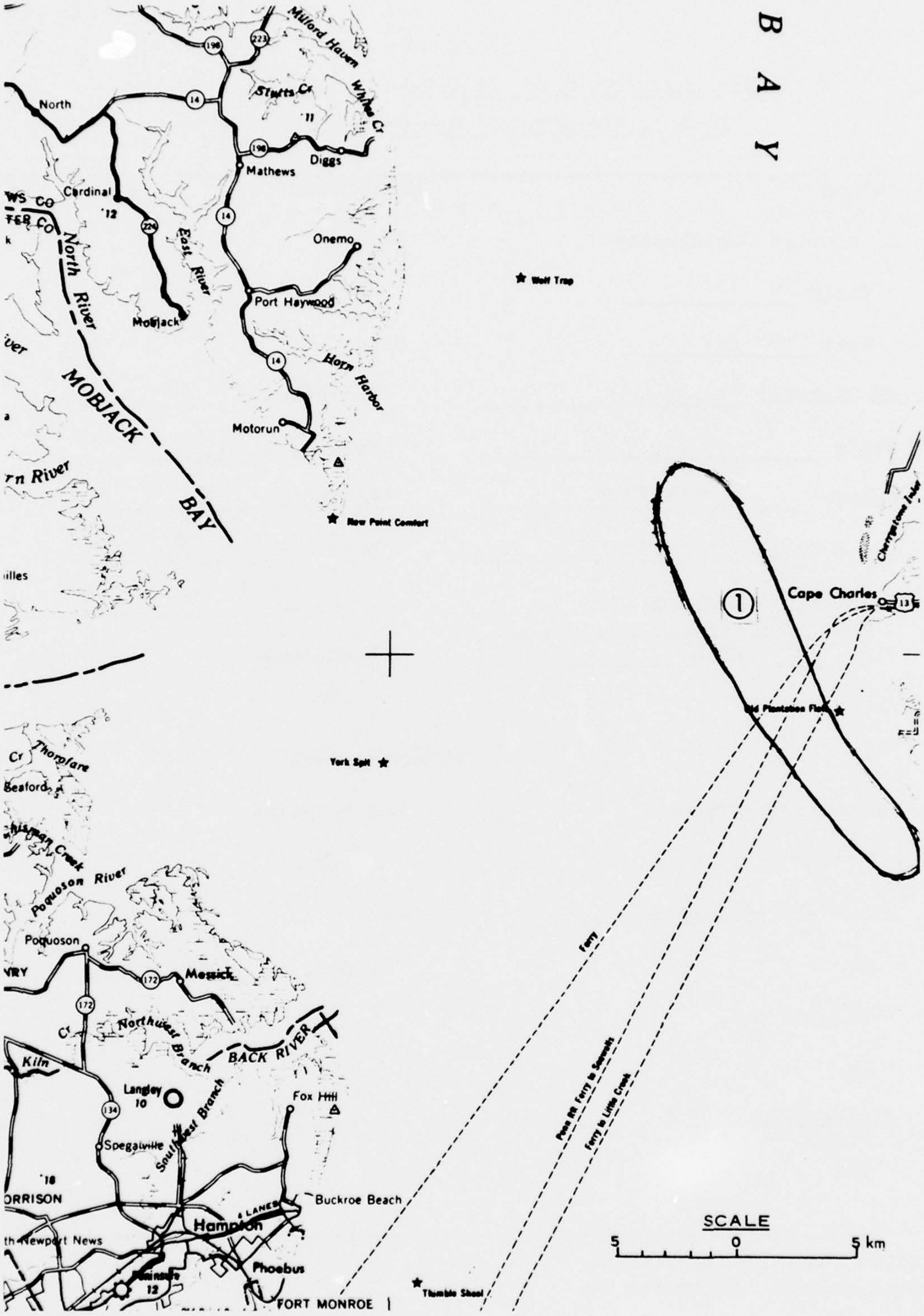


Figure 24. Subaqueous site location, vicinity of Cape Charles, Virginia

Table 50

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Cape Charles, Virginia

Location	Description
Geographic Coordinates	**Shape**
North 37^{o} 15'	Linear
West 76^{o} 05'	**Size**
CE District Norfolk	Diameter, m NA
State Virginia	Length, m 0135
County Northampton	Width, m 024
C & G Chart 1222	Depth, m NA
1:250,000 Topographic Map Richmond	Area, km^2 32.5
Fig. 24 Site 1	**Bank Angle**
	NA
History	
NA	**Environment**
Excavation Method	**Bed Materials**
Natural	NA
Material Utilization	**Water**
NA	Depth, m NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 59.

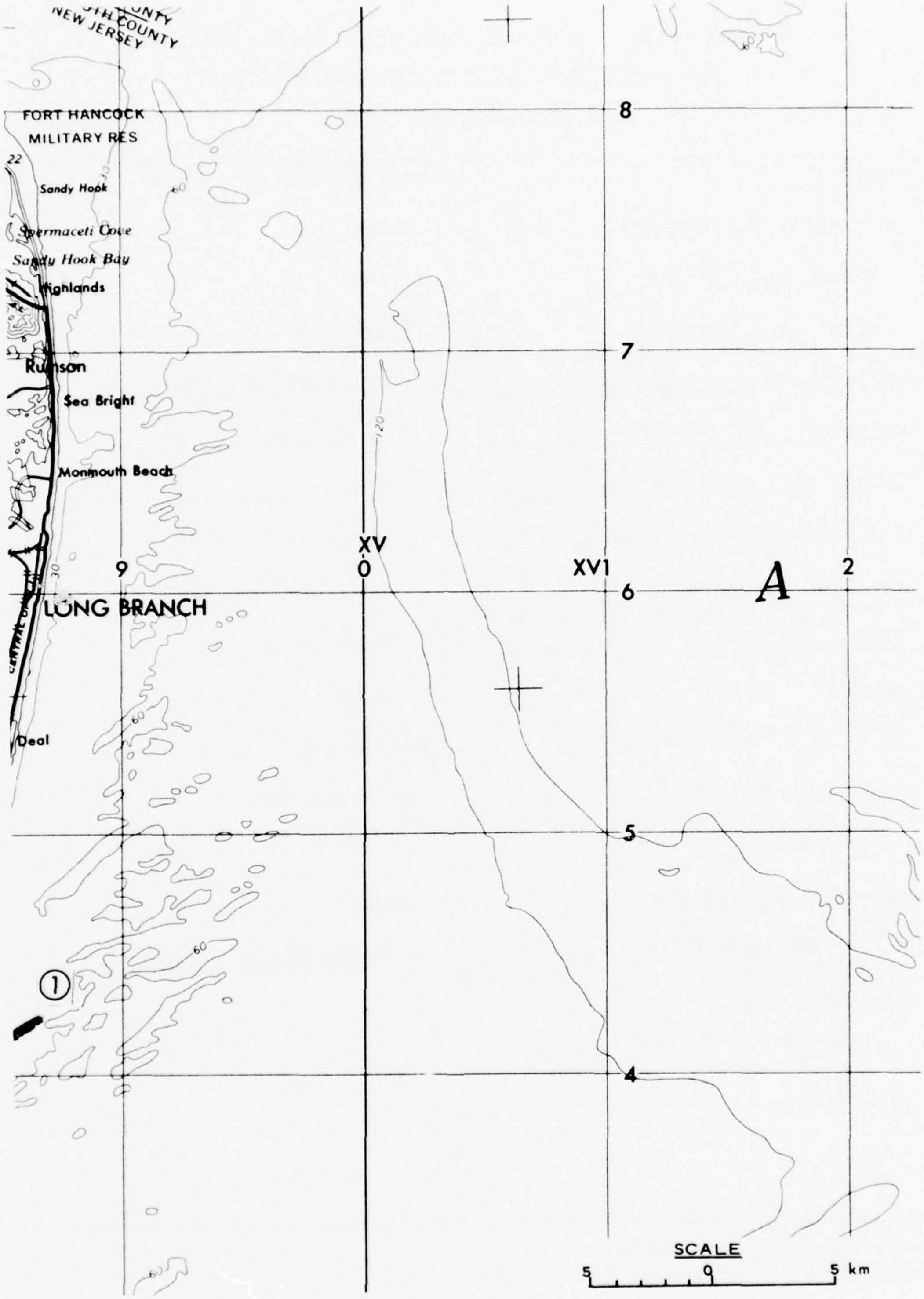


Figure 25. Subaqueous site location, vicinity of Long Branch, New Jersey, New York topographic map

Table 51

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Long Branch, New Jersey

New York Topographic Map

Location	Description
Geographic Coordinates	**Shape**
North 40° 07' 35"	NA
West 73° 59' 30"	**Size**
CE District Philadelphia	Diameter, m NA
State New Jersey	Length, m 124
County Monmouth	Width, m 19
C & G Chart 824-SC, 1215	Depth, m NA
1:250,000 Topographic Map New York	Area, km^2 0.24
Fig. 25 Site 1	**Bank Angle**
History	NA
Initiated in March 1966	**Environment**
Excavation Method	**Bed Materials**
Hydraulic	Sand
Material Utilization	**Water**
Coastal Nourishment 250,000 cu yd	Depth, m 9
Available Data	
Physical	
Alterations	
NA	

Note: NA = not available.
Data Source: References 21, 25, 26.

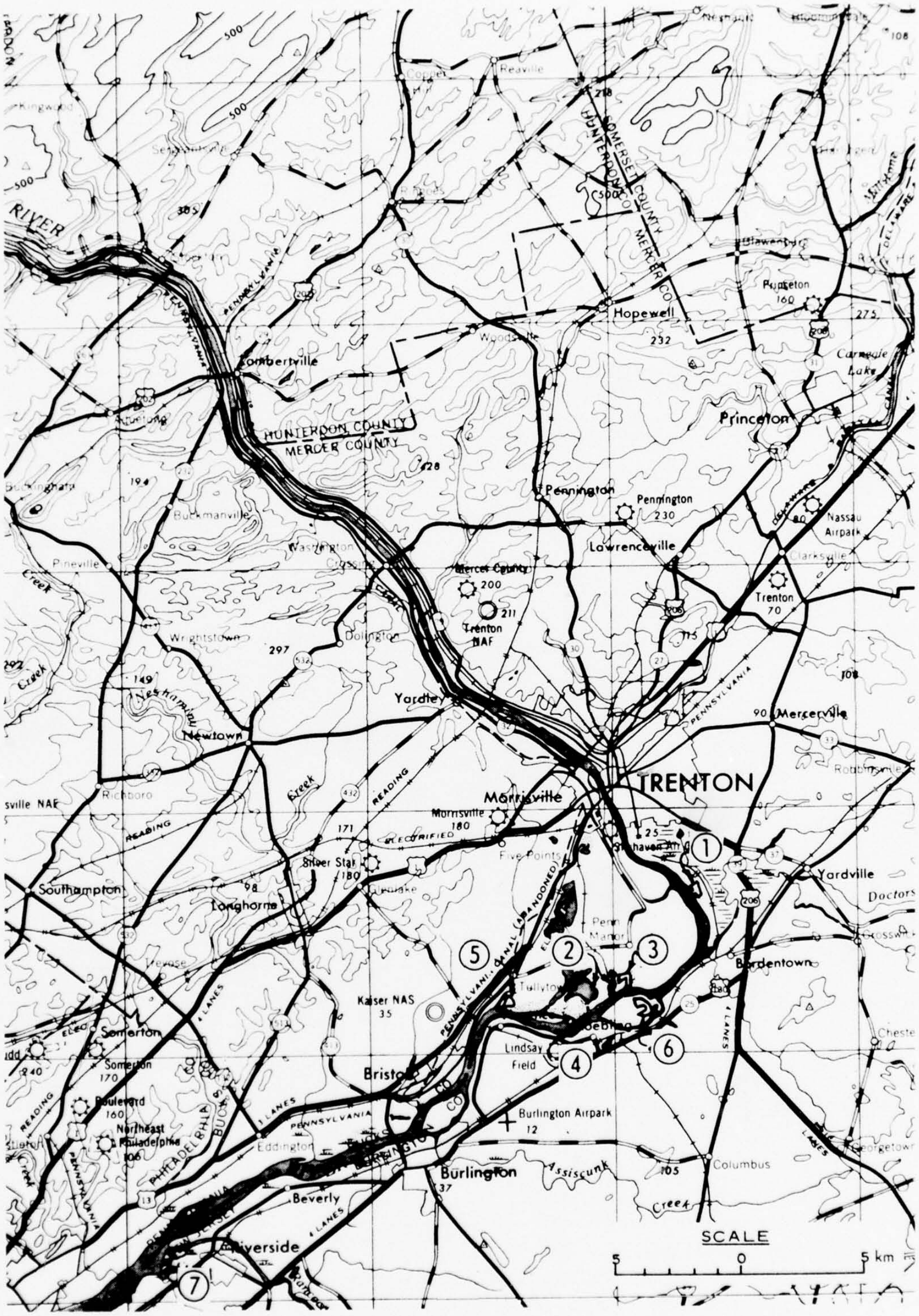


Figure 26. Subaqueous site location, vicinity of Trenton, New Jersey

Table 52

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Trenton, New Jersey

Location

Geographic Coordinates

North 40° 10' 15"

West 74° 43' 30"

CE District Philadelphia

State New Jersey

County Mercer

C & G Chart 296

1:250,000 Topographic Map Newark

Fig. 26 Site 1

History

Initiated in 1945 } Continuous
Completed in 1967 } Operation

Excavation Method

NA

Material Utilization

Aggregate

Available Data

NA

Alterations

Yes

Description

Shape

Rectangular

Size

Diameter, m NA

Length, m 366

Width, m 366

Depth, m NA

Area, km^2 0.134

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Philadelphia, CE.

Table 53

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, Vicinity of Trenton, New Jersey

Location

Geographic Coordinates

North $40^{\circ}08'05''$

West $74^{\circ}46'45''$ to $74^{\circ}45'55''$

CE District Philadelphia

State Pennsylvania

County Bucks

C & G Chart 296

1:250,000 Topographic Map Newark

Fig. 26 Site 2

History

NA

Excavation Method

NA

Material Utilization

Aggregate

Available Data

NA

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m NA

Area, km^2 0.908

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Philadelphia, CE.

Table 54

Subaqueous Pit, Hole, or Depression Characteristics

Site 3, Vicinity of Trenton, New Jersey

Location

Geographic Coordinates

North 40° 08' 15"

West 74° 45' 35'

CE District Philadelphia

State Pennsylvania

County Bucks

C & G Chart 296

1:250,000 Topographic Map Newark

Fig. 26 **Site** 3

History

Initiated in 1948
Completed in 1967
continuous operation

Excavation Method

Mechanical
Hydraulic

Material Utilization

Aggregate

Available Data

NA

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m 732

Width, m 160

Depth, m NA

Area, km^2 0.117

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Philadelphia, CE.

Table 55

Subaqueous Pit, Hole, or Depression Characteristics

Site 4, Vicinity of Trenton, New Jersey

Location	Description
Geographic Coordinates	Shape
North 40°07'20"	Linear
West 74°47'05"	Size
CE District Philadelphia	Diameter, m NA
State Pennsylvania	Length, m 1676
County Bucks	Width, m 183
C & G Chart 296	Depth, m NA
1:250,000 Topographic Map Newark	Area, km^2 0.307
Fig. 26 Site 4	Bank Angle
History	NA
Initiated in 1960	Environment
Excavation Method	Bed Materials
NA	NA
Material Utilization	Water
Aggregate	Depth, m NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: U. S. Army Engineer District, Philadelphia, CE.

Table 56

Subaqueous Pit, Hole, or Depression Characteristics

Site 5, Vicinity of Trenton, New Jersey

Location

Geographic Coordinates

North $40^{\circ}07'55''$

West $74^{\circ}48'55''$

CE District Philadelphia

State Pennsylvania

County Bucks

C & G Chart 296

1:250,000 Topographic Map Newark

Fig. 26 Site 5

History

Initiated in 1947

Excavation Method

NA

Material Utilization

Aggregate

Available Data

NA

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m NA

Area, km^2 0.08

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Philadelphia, CE.

Table 57

Subaqueous Pit, Hole, or Depression Characteristics

Site 6, Vicinity of Trenton, New Jersey

Location

Geographic Coordinates

North $40^{\circ}07'45''$

West $74^{\circ}45'00''$

CE District Philadelphia

State Pennsylvania

County Bucks

C & G Chart 296

1:250,000 Topographic Map Newark

Fig. 26 Site 6

History

NA

Excavation Method

Hydraulic

Material Utilization

Aggregate

Available Data

NA

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 11.7

Area, km^2 0.36

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Philadelphia, CE.

Table 58

Subaqueous Pit, Hole, or Depression Characteristics

Site 7, Vicinity of Trenton, New Jersey

Location

Geographic Coordinates

North $40^{\circ}02'25''$

West $74^{\circ}58'40''$

CE District Philadelphia

State New Jersey

County Burlington

C & G Chart 296

1:250,000 Topographic Map Newark

Fig. 26 Site 7

History

Initiated in 1967 ?

Excavation Method

Mechanical

Material Utilization

Aggregate

Available Data

NA

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m 594

Width, m 183

Depth, m NA

Area, km^2 0.109

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m 7.6

Note: NA = not available.
Data Source: U. S. Army Engineer District, Philadelphia, CE.

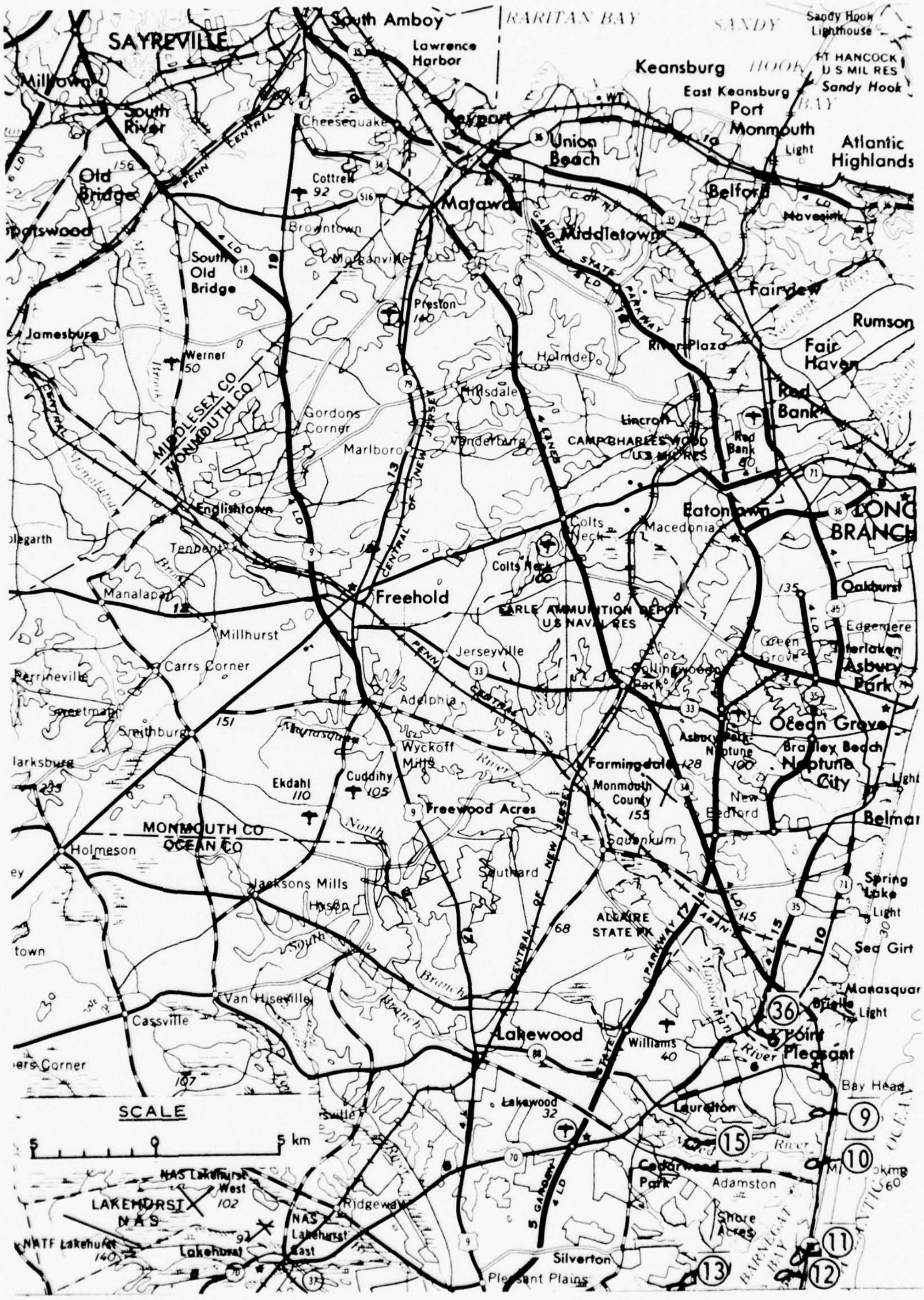


Figure 27. Subaqueous site locations, vicinity of Long Branch, New Jersey

Table 59

Subaqueous Pit, Hole, or Depression Characteristics

Site 9, Vicinity of Long Branch, New Jersey

Location	Description
Geographic Coordinates	Shape
North $40^{\circ}03'55''$	Circular
West $74^{\circ}03'10''$	Size
CE District Philadelphia	Diameter, m NA
State New Jersey	Length, m NA
County Ocean	Width, m NA
C & G Chart 824-SC, 1216	Depth, m 7.6
1:250,000 Topographic Map Newark	Area, km^2 0.1416
Fig. 27 Site 9	Bank Angle
History	NA
Initiated in 1962 Completed in 1962	Environment
Excavation Method	Bed Materials
NA	NA
Material Utilization	Water
Coastal Nourishment	Depth, m NA
Available Data Physical Chemical Biological	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 3.

Table 60

Subaqueous Pit, Hole, or Depression Characteristics

Site 10, Vicinity of Long Branch, New Jersey

Location

Geographic Coordinates

North $40^{\circ}02'50''$

West $74^{\circ}03'20''$

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Newark

Fig. 27 Site 10

History

Initiated in 1962
Completed in 1962

Excavation Method

NA

Material Utilization

Coastal Nourishment

Available Data
- Physical
- Chemical
- Biological

Alterations

NA

Description

Shape

Circular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 7.3

Area, km^2 0.04

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 61

Subaqueous Pit, Hole, or Depression Characteristics

Site 11, Vicinity of Long Branch, New Jersey

Location

Geographic Coordinates

North 40°01'40"

West 74°03'50"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Newark

Fig. 27 **Site** 11

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

Circular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 7.3

Area, km^2 0.004

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 62

Subaqueous Pit, Hole, or Depression Characteristics

Site 12, Vicinity of Long Branch, New Jersey

Location

Geographic Coordinates

North $40^{\circ}00'20''$

West $74^{\circ}04'20''$

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Newark

Fig. 27 Site 12

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data
Physical
Chemical
Biological

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 7.3

Area, km^2 0.02

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 63

Subaqueous Pit, Hole, or Depression Characteristics

Site 13, Vicinity of Long Branch, New Jersey

Location

Geographic Coordinates

North 40°00'00"

West 74°07'15"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Newark

Fig. 27 **Site** 13

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 9.1

Area, km^2 0.03

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 64

Subaqueous Pit, Hole, or Depression Characteristics

Site 15, Vicinity of Long Branch, New Jersey

Location

Geographic Coordinates

North 40°03'15"

West 74°06'45"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Newark

Fig. 27 **Site** 15

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

Circular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 10.4

Area, km^2 0.06

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 65

Subaqueous Pit, Hole, or Depression Characteristics

Site 36, Vicinity of Long Branch, New Jersey

Location	Description
Geographic Coordinates	Shape
North $40^{\circ}05'40''$	Circular
West $74^{\circ}04'30''$	Size
CE District Philadelphia	Diameter, m NA
State New Jersey	Length, m NA
County Monmouth	Width, m NA
C & G Chart 795	Depth, m 3.7
1:250,000 Topographic Map Newark	Area, km^2 0.06
Fig. 27 Site 36	Bank Angle
	NA
History	
NA	Environment
Excavation Method	Bed Materials
NA	NA
Material Utilization	Water
NA	Depth, m NA
Available Data	
Physical	
Chemical	
Biological	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 3.

Table 66

Subaqueous Pit, Hole, or Depression Characteristics

Site 3, U. S. Army Engineer District, Philadelphia

Location

Geographic Coordinates

North 38° 36' 20"

West 75° 03' 30"

CE District Philadelphia

State Delaware

County Sussex

C & G Chart 411

1:250,000 Topographic Map Salisbury

Fig. 3 Site 3

History

Initiated 8 December 1972
Completed 12 June 1973

Excavation Method

Hydraulic

Material Utilization

Coastal Nourishment

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 914

Width, m 152

Depth, m NA

Area, km^2 0.139

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Philadelphia, CE.

Figure 28. Subaqueous site locations, vicinity of Atlantic City, New Jersey

Table 67

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Atlantic City, New Jersey

Location	Description
Geographic Coordinates	Shape
North 39° 17' 30"	Rectangular
West 74° 34' 30"	Size
CE District Philadelphia	Diameter, m NA
State New Jersey	Length, m 914
County Cape May	Width, m 671
C & G Chart 826-SC or 1217	Depth, m 12
1:250,000 Topographic Map Wilmington	Area, km^2 0.613
Fig. 28 Site 1	Bank Angle
	NA
History	
Initiated in 1970 In progress	Environment
Excavation Method	Bed Materials
Hydraulic	
Material Utilization	Water
Coastal Nourishment	Depth, m NA
Available Data	
NA	
Alterations	
NA	

Note: NA = not available.
Data Source: U. S. Army Engineer District, Philadelphia, CE.

Table 68

Subaqueous Pit, Hole, or Depression Characteristics

Site 31, Vicinity of Atlantic City, New Jersey

Location

Geographic Coordinates

North 39° 27' 05"

West 74° 29' 50"

CE District Philadelphia

State New Jersey

County Atlantic

C & G Chart 826-SC, 1217

1:250,000 Topographic Map Wilmington

Fig. 28 **Site** 31

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 18.9

Area, km² 0.06

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 69

Subaqueous Pit, Hole, or Depression Characteristics

Site 32, Vicinity of Atlantic City, New Jersey

Location

Geographic Coordinates

North 39° 27' 25"

West 74° 29' 50"

CE District Philadelphia

State New Jersey

County Atlantic

C & G Chart 826-SC, 1217

1:250,000 Topographic Map Wilmington

Fig. 28 Site 32

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical

Chemical

Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 14.3

Area, km^2 0.08

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.

Data Source: Reference 3.

Table 70

Subaqueous Pit, Hole, or Depression Characteristics

Site 33, Vicinity of Atlantic City, New Jersey

Location

Geographic Coordinates

North 39° 21' 40"

West 74° 33' 25"

CE District Philadelphia

State New Jersey

County Atlantic

C & G Chart 826-SC, 1217

1:250,000 Topographic Map Wilmington

Fig. 28 Site 33

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 7.3

Area, km^2 0.06

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 71

Subaqueous Pit, Hole, or Depression Characteristics

Site 34, Vicinity of Atlantic City, New Jersey

Location

Geographic Coordinates

North 39° 13' 45"

West 74° 39' 00"

CE District Philadelphia

State New Jersey

County Cape May

C & G Chart 826-SC, 1217

1:250,000 Topographic Map Wilmington

Fig. 28 Site 34

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 11.6

Area, km^2 0.02

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 72

Subaqueous Pit, Hole, or Depression Characteristics

Site 35, Vicinity of Atlantic City, New Jersey

Location

Geographic Coordinates

North 39° 10' 15"

West 74° 41' 20"

CE District Philadelphia

State New Jersey

County Cape May

C & G Chart 826-SC, 1217

1:250,000 Topographic Map Wilmington

Fig. 28 Site 35

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 13.1

Area, km^2 0.06

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 73

Subaqueous Pit, Hole, or Depression Characteristics

Site 44, Vicinity of Atlantic City, New Jersey

Location	Description
Geographic Coordinates	Shape
North 39° 24' 45"	NA
West 74° 29' 05"	Size
CE District Philadelphia	Diameter, m NA
State New Jersey	Length, m NA
County Atlantic	Width, m NA
C & G Chart 826-SC, 1217	Depth, m 8.2
1:250,000 Topographic Map Wilmington	Area, km^2 0.02
Fig. 28 Site 44	Bank Angle
History	NA
NA	Environment
Excavation Method	Bed Materials
NA	NA
Material Utilization	Water
NA	Depth, m NA
Available Data	
Physical	
Chemical	
Biological	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 3.

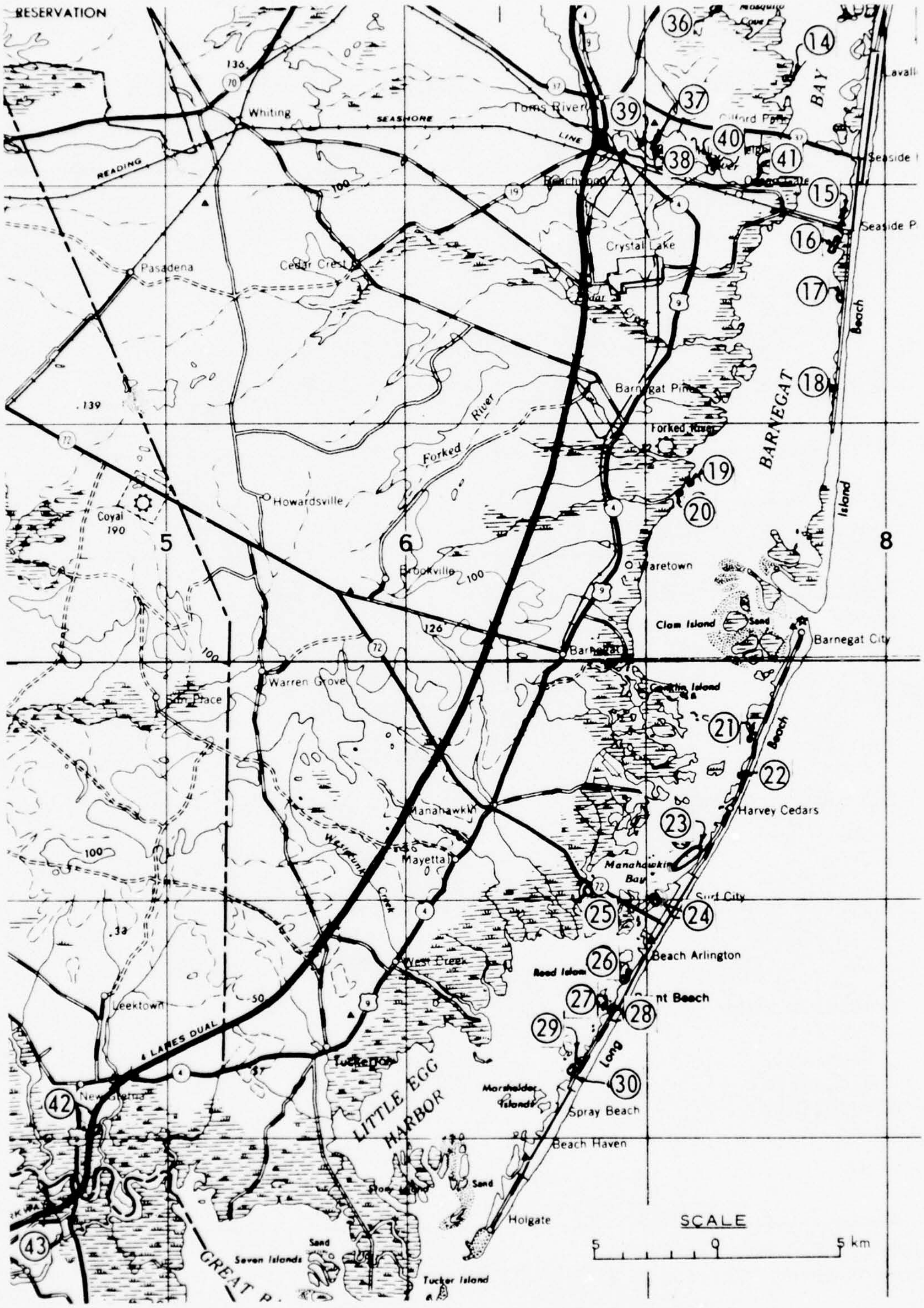


Figure 29. Subaqueous site locations, vicinity of Barnegat Bay, New Jersey

Table 74

Subaqueous Pit, Hole, or Depression Characteristics

Site 14, Vicinity of Barnegat Bay, New Jersey

Location	Description
Geographic Coordinates	**Shape**
North 39° 58' 10"	NA
West 74° 06' 30"	**Size**
CE District Philadelphia	**Diameter, m** NA
State New Jersey	**Length, m** NA
County Ocean	**Width, m** NA
C & G Chart 824-SC, 1216	**Depth, m** 4.6
1:250,000 Topographic Map Wilmington	**Area, km^2** 0.015
Fig. 29 **Site** 14	**Bank Angle**
History	NA
NA	**Environment**
Excavation Method	**Bed Materials**
NA	NA
Material Utilization	**Water**
NA	**Depth, m** NA
Available Data	
Physical	
Chemical	
Biological	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 3.

Table 75

Subaqueous Pit, Hole, or Depression Characteristics

Site 15, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 55' 05"

West 74° 05' 00"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 15

History

Initiated 1962
Completed 1962

Excavation Method

NA

Material Utilization

Coastal Nourishment

Available Data
Physical
Chemical
Biological

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 3.0

Area, km^2 0.10

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 76

Subaqueous Pit, Hole, or Depression Characteristics

Site 16, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 74° 05' 10"

West 39° 54' 25"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 **Site** 16

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data
Physical
Chemical
Biological

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 4.3

Area, km^2 0.06

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 77

Subaqueous Pit, Hole, or Depression Characteristics

Site 17, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 53' 15"

West 74° 05' 05"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 17

History

Initiated 1962
Completed 1962

Excavation Method

NA

Material Utilization

Coastal Nourishment

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 4.3

Area, km^2 0.02

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 78

Subaqueous Pit, Hole, or Depression Characteristics

Site 18, Vicinity of Barnegat Bay, New Jersey

Location	Description
Geographic Coordinates	Shape
North 39° 51' 05"	NA
West 74° 05' 25"	Size
CE District Philadelphia	Diameter, m NA
State New Jersey	Length, m NA
County Ocean	Width, m NA
C & G Chart 824-SC, 1216	Depth, m 2.7
1:250,000 Topographic Map Wilmington	Area, km^2 0.02
Fig. 29 Site 18	Bank Angle
	NA
History	
NA	Environment
Excavation Method	Bed Materials
NA	NA
Material Utilization	Water
NA	Depth, m NA
Available Data Physical Chemical Biological	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 3.

Table 79

Subaqueous Pit, Hole, or Depression Characteristics

Site 19, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 49' 00"

West 74° 09' 30"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 19

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data
Physical
Chemical
Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 3.0

Area, km^2 0.008

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 80

Subaqueous Pit, Hole, or Depression Characteristics

Site 20, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 48' 50"

West 74° 09' 50"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 20

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 3.0

Area, km^2 0.008

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 81

Subaqueous Pit, Hole, or Depression Characteristics

Site 21, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 43' 15"

West 74° 07' 50"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 **Site** 21

History

Initiated 1962
Completed 1962

Excavation Method

NA

Material Utilization

Coastal Nourishment

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 7.0

Area, km^2 0.02

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 82

Subaqueous Pit, Hole, or Depression Characteristics

Site 22, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 42' 25"

West 74° 08' 10"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 22

History

Initiated 1962
Completed 1962

Excavation Method

NA

Material Utilization

Coastal Nourishment

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 11.6

Area, km^2 0.02

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 83

Subaqueous Pit, Hole, or Depression Characteristics

Site 23, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 40' 35"

West 74° 09' 45"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 **Site** 23

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 6.7

Area, km^2 0.30

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 84

Subaqueous Pit, Hole, or Depression Characteristics

Site 24, Vicinity of Barnegat Bay, New Jersey

Location	Description
Geographic Coordinates	**Shape**
North 39° 39' 30"	NA
West 74° 10' 45"	**Size**
CE District Philadelphia	Diameter, m NA
State New Jersey	Length, m NA
County Ocean	Width, m NA
C & G Chart 824-SC, 1216	Depth, m 10.4
1:250,000 Topographic Map Wilmington	Area, km^2 0.10
Fig. 29 Site 24	**Bank Angle**
History	NA
Initiated 1962 Completed 1962	**Environment**
Excavation Method	**Bed Materials**
NA	NA
Material Utilization	**Water**
Coastal Nourishment	Depth, m NA
Available Data Physical Chemical Biological	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 3.

Table 85

Subaqueous Pit, Hole, or Depression Characteristics

Site 25, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 39' 45"

West 74° 12' 40"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 25

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data
- Physical
- Chemical
- Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 8.5

Area, km^2 0.07

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 86

Subaqueous Pit, Hole, or Depression Characteristics

Site 26, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 37' 45"

West 74° 11' 40"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 26

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data
Physical
Chemical
Biological

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 10.4

Area, km^2 0.14

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 87

Subaqueous Pit, Hole, or Depression Characteristics

Site 27, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 37' 05"

West 74° 12' 00"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 27

History

Initiated 1962
Completed 1962

Excavation Method

NA

Material Utilization

Coastal Nourishment

Available Data

Physical
Chemical

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 10.1

Area, km^2 0.06

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 88

Subaqueous Pit, Hole, or Depression Characteristics

Site 28, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 37' 05"

West 74° 12' 15"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 28

History

Initiated 1962
Completed 1962

Excavation Method

NA

Material Utilization

Coastal Nourishment

Available Data

Physical
Chemical

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 9.1

Area, km^2 0.01

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 89

Subaqueous Pit, Hole, or Depression Characteristics

Site 29, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 35' 55"

West 74° 13' 00"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 29

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 5.5

Area, km^2 0.01

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 90

Subaqueous Pit, Hole, or Depression Characteristics

Site 30, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 35' 40"

West 74° 13' 15"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 30

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 5.2

Area, km^2 0.05

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 91

Subaqueous Pit, Hole, or Depression Characteristics

Site 36, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 59' 45"

West 74° 08' 35"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 36

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

Circular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 6.1

Area, km^2 0.02

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 92

Subaqueous Pit, Hole, or Depression Characteristics

Site 37, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 56' 50"

West 74° 10' 20"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 37

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 9.1

Area, km^2 0.004

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 93

Subaqueous Pit, Hole, or Depression Characteristics

Site 38, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 56' 35"

West 74° 10' 30"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 38

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data
Physical
Chemical
Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 8.5

Area, km^2 0.004

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 94

Subaqueous Pit, Hole, or Depression Characteristics

Site 39, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 56' 45"

West 74° 10' 55"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 39

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 11.6

Area, km^2 0.10

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 95

Subaqueous Pit, Hole, or Depression Characteristics

Site 40, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 56' 15"

West 74° 08' 45"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 40

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical
Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 5.2

Area, km^2 0.04

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 96

Subaqueous Pit, Hole, or Depression Characteristics

Site 41, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 55' 50"

West 74° 07' 30"

CE District Philadelphia

State New Jersey

County Ocean

C & G Chart 824-SC, 1216

1:250,000 Topographic Map Wilmington

Fig. 29 Site 41

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data
- Physical
- Chemical
- Biological

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 4.0

Area, km^2 0.01

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Table 97

Subaqueous Pit, Hole, or Depression Characteristics

Site 42, Vicinity of Barnegat Bay, New Jersey

Location	Description
Geographic Coordinates	Shape
North 39° 34' 25"	NA
West 74° 27' 05"	Size
CE District Philadelphia	Diameter, m NA
State New Jersey	Length, m NA
County Burlington	Width, m NA
C & G Chart 826-SC	Depth, m 14.6
1:250,000 Topographic Map Wilmington	Area, km^2 0.14
Fig. 29 Site 42	Bank Angle
History	NA
NA	Environment
Excavation Method	Bed Materials
NA	NA
Material Utilization	Water
NA	Depth, m NA
Available Data	
Physical	
Chemical	
Biological	
Alterations	
NA	

Note: NA = not available.
Data Source: Reference 3.

Table 98

Subaqueous Pit, Hole, or Depression Characteristics

Site 43, Vicinity of Barnegat Bay, New Jersey

Location

Geographic Coordinates

North 39° 33' 00"

West 74° 28' 45"

CE District Philadelphia

State New Jersey

County NA

C & G Chart 826-SC

1:250,000 Topographic Map Wilmington

Fig. 29 Site 43

History

NA

Excavation Method

NA

Material Utilization

NA

Available Data

Physical
Chemical

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 10.4

Area, km^2 0.03

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: Reference 3.

Figure 30. Subaqueous site location, vicinity of Philadelphia, Pennsylvania

Table 99

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, Vicinity of Philadelphia, Pennsylvania

Location

Geographic Coordinates

North 39° 54' 50"

West 75° 08' 00"

CE District Philadelphia

State Pennsylvania

County Philadelphia

C & G Chart 295

1:250,000 Topographic Map Wilmington

Fig. 30 **Site** 2

History

Initiated 1972 ?

Excavation Method

Mechanical

Material Utilization

Fill

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 1707

Width, m 274

Depth, m NA

Area, km^2 0.468

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m 16.8

Note: NA = not available.
Data Source: U. S. Army Engineer District, Philadelphia, CE.

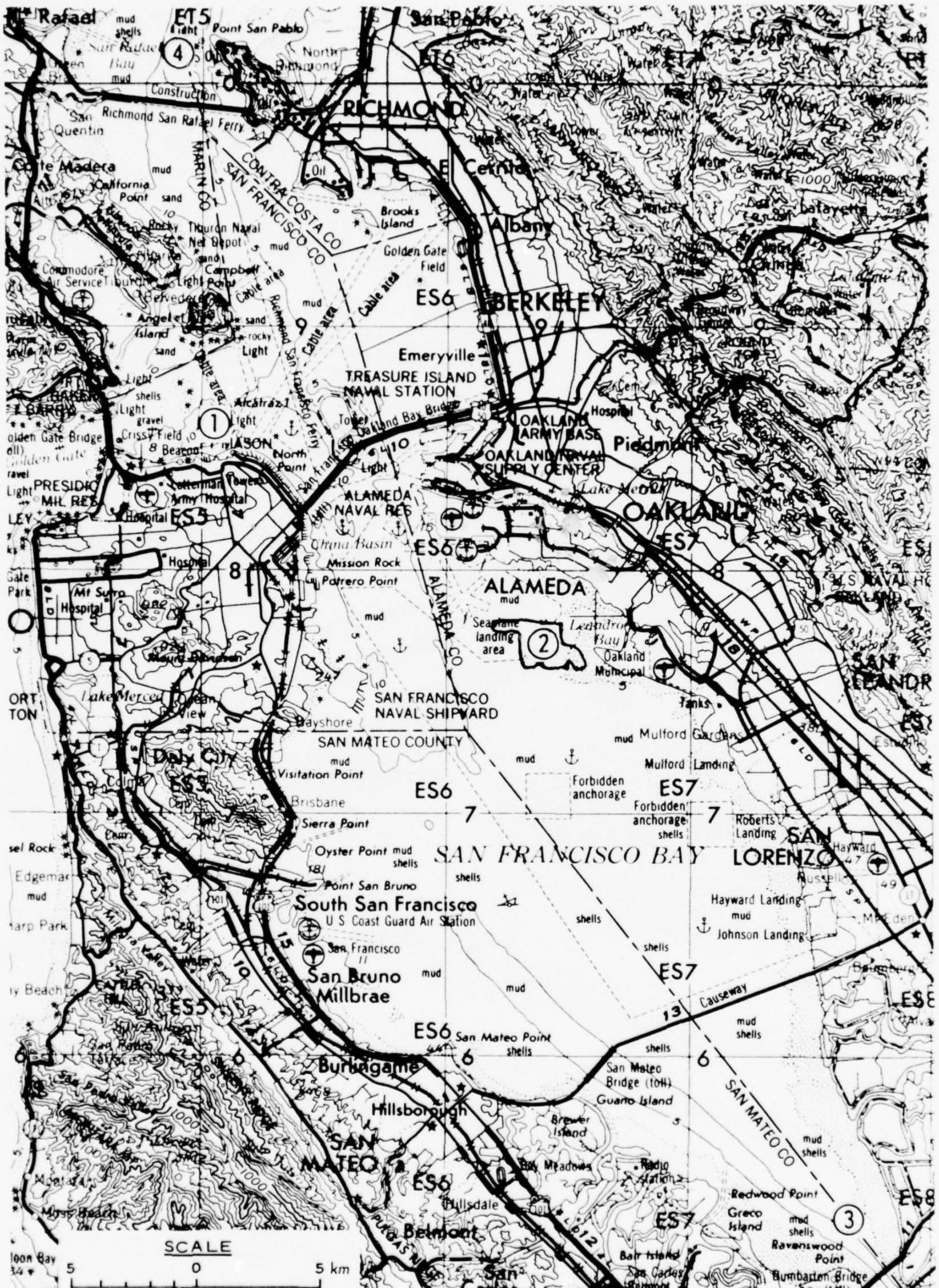


Figure 31. Subaqueous site locations, vicinity of San Francisco, California

Table 100

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of San Francisco, California

Location

Geographic Coordinates

North 37°49'17"

West 122°25'24"

CE District San Francisco

State California

County San Francisco

C & G Chart 5535

1:250,000 Topographic Map San Francisco

Fig. 31 **Site** 1

History

NA

Excavation Method

Natural

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Circular

Size

Diameter, m 305

Length, m NA

Width, m NA

Depth, m 30

Area, km^2 0.292

Bank Angle NA

Environment

Bed Materials

Water

Depth, m 18-50

Note: NA = not available.
Data Source: Reference 60.

Table 101

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, Vicinity of San Francisco, California

Location

Geographic Coordinates

North 37°44'25"

West 122°16'35"

CE District San Francisco

State California

County Alameda

C & G Chart 5535

1:250,000 Topographic Map San Francisco

Fig. 31 **Site** 2

History

Completed January 1969

Excavation Method

Mechanical

Material Utilization

Fill

Available Data

Physical

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m 3353

Width, m 1524

Depth, m 8.2 - 14.6

Area, km² 5.110

Bank Angle NA

Environment

Bed Materials

Sand

Water

Depth, m 0.30 - 3.7

Note: NA = not available.
Data Source: Reference 8 and U. S. Army Engineer District, San Francisco, CE.

Table 102

Subaqueous Pit, Hole, or Depression Characteristics

Site 3, Vicinity of San Francisco, California

Location

Geographic Coordinates

North $37^{\circ}30'$

West $122^{\circ}06'$

CE District San Francisco

State California

County San Mateo and Alameda

C & G Chart 5531

1:250,000 Topographic Map San Francisco

Fig. 31 **Site** 3

History

NA

Excavation Method

Hydraulic

Material Utilization

Aggregate

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 15,000

Width, m 1000

Depth, m 12

Area, km^2 NA

Bank Angle

< 20 deg

Environment

Bed Materials

Shell

Water

Depth, m 1

Note: NA = not available.
Data Source: Reference 61.

Table 103

Subaqueous Pit, Hole, or Depression Characteristics

Site 4, Vicinity of San Francisco, California

Location

Geographic Coordinates

North 37°57'

West 122°26'

CE District San Francisco

State California

County Marin and Contra Costa

C & G Chart 5533

1:250,000 Topographic Map San Francisco

Fig. 31 **Site** 4

History

NA

Excavation Method

Natural

Material Utilization

NA

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 5000

Width, m 1000

Depth, m 25

Area, km^2 NA

Bank Angle

< 20 deg

Environment

Bed Materials

NA

Water

Depth, m 8

Note: NA = not available.
Data Source: Reference 62.

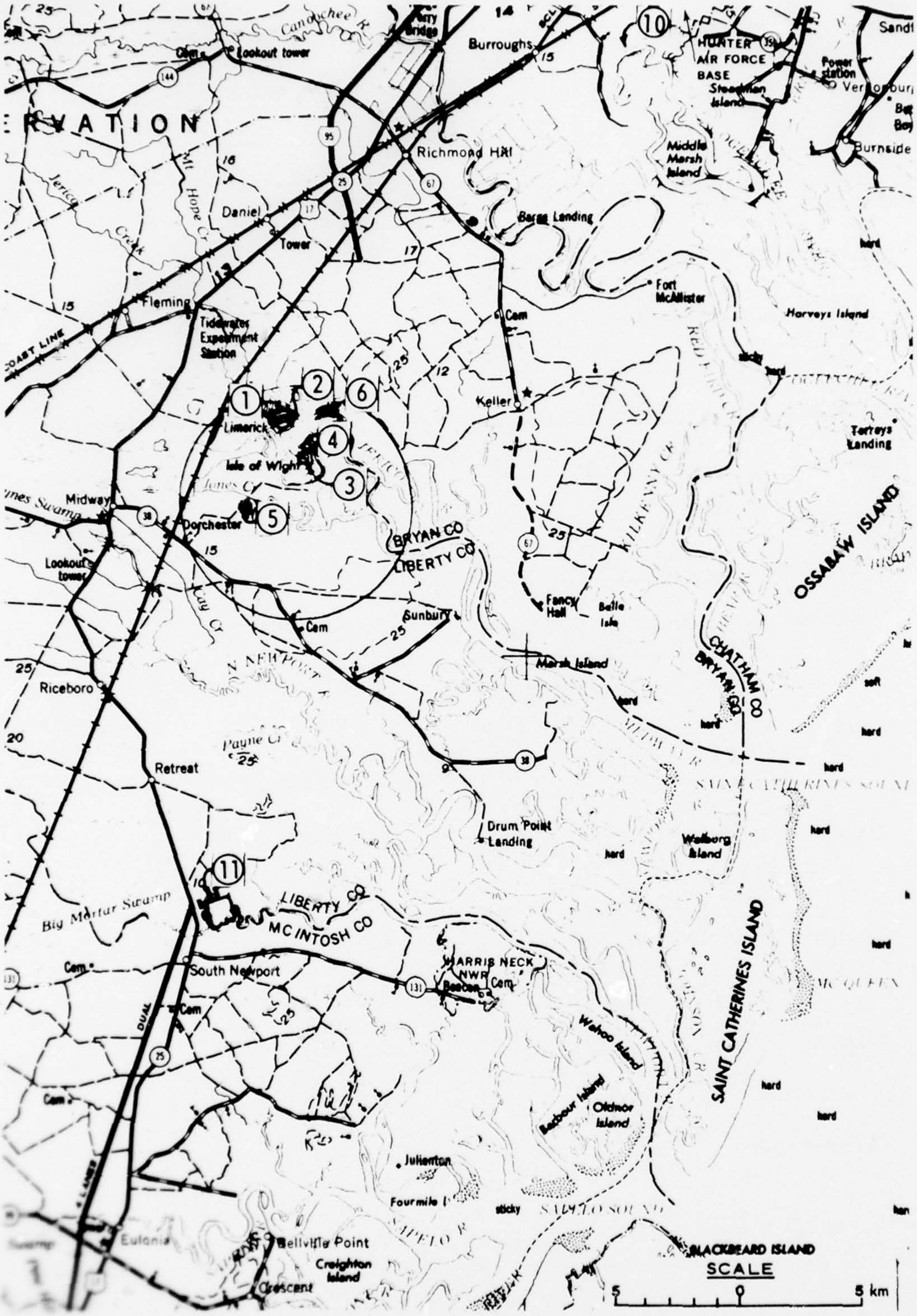


Figure 32. Subaqueous site locations, vicinity of Sapelo Sound, Georgia

Table 104

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Sapelo Sound, Georgia

Location

Geographic Coordinates

North 31° 50' 30"

West 81° 21' 20"

CE District Savannah

State Georgia

County Bryan

C & G Chart 573, 1241

1:250,000 Topographic Map Brunswick, Georgia

Fig. 32 **Site** 1

History

Initiated 1971

Excavation Method

Hydraulic

Material Utilization

Fill

Available Data

Physical

Alterations

NA

Description

Shape

Rectangular

Size

Diameter, m NA

Length, m 792

Width, m 213

Depth, m NA

Area, km^2 0.17

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Savannah, CE.

Table 105

Subaqueous Pit, Hole, or Depression Characteristics

Site 2, Vicinity of Sapelo Sound, Georgia

Location

Geographic Coordinates

North 31° 50' 15"

West 81^{0} 21' 20"

CE District Savannah

State Georgia

County Liberty

C & G Chart 573, 1241

1:250,000 Topographic Map Brunswick, Georgia

Fig. 32 **Site** 2

History

Initiated 1971

Excavation Method

Hydraulic

Material Utilization

Fill

Available Data

Physical

Alterations

NA

Description

Shape

Rectangular

Size

Diameter, m NA

Length, m 625

Width, m 396

Depth, m NA

Area, km^2 0.25

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Savannah, CE.

Table 106

Subaqueous Pit, Hole, or Depression Characteristics

Site 3, Vicinity of Sapelo Sound, Georgia

Location

Geographic Coordinates

North 31° 49' 30"

West 81° 20' 50"

CE District Savannah

State Georgia

County Liberty

C & G Chart 573, 1241

1:250,000 Topographic Map Brunswick, Georgia

Fig. 32 **Site** 3

History

Initiated 1971

Excavation Method

Hydraulic

Material Utilization

Fill

Available Data

Physical

Alterations

NA

Description

Shape

Rectangular

Size

Diameter, m NA

Length, m 533

Width, m 152

Depth, m NA

Area, km^2 0.08

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Savannah, CE.

Table 107

Subaqueous Pit, Hole, or Depression Characteristics

Site 4, Vicinity of Sapelo Sound, Georgia

Location	Description
Geographic Coordinates	Shape
North 31° 49' 45"	Irregular
West 81° 20' 45"	Size
CE District Savannah	Diameter, m NA
State Georgia	Length, m 500
County Bryan	Width, m 380
C & G Chart 573, 1241	Depth, m NA
1:250,000 Topographic Map Brunswick, Georgia	Area, km^2 0.19
Fig. 32 Site 4	Bank Angle
History	NA
Initiated 1971	Environment
Excavation Method	Bed Materials
Hydraulic	NA
Material Utilization	Water
Fill	Depth, m NA
Available Data	
Physical	
Alterations	
NA	

Note: NA = not available.
Data Source: U. S. Army Engineer District, Savannah, CE.

Table 108

Subaqueous Pit, Hole, or Depression Characteristics

Site 5, Vicinity of Sapelo Sound, Georgia

Location

Geographic Coordinates

North 31° 43' 25"

West 81° 22' 20"

CE District Savannah

State Georgia

County Liberty

C & G Chart 573, 1241

1:250,000 Topographic Map Brunswick, Georgia

Fig. 32 **Site** 5

History

Initiated 1971

Excavation Method

Hydraulic

Material Utilization

Fill

Available Data

Physical

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m NA

Area, km^2 NA

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Savannah, CE.

Table 109

Subaqueous Pit, Hole, or Depression Characteristics

Site 6, Vicinity of Sapelo Sound, Georgia

Location

Geographic Coordinates

North 31° 50' 30"

West 81° 20' 15"

CE District Savannah

State Georgia

County Liberty-Bryan

C & G Chart 573, 1241

1:250,000 Topographic Map Brunswick, Georgia

Fig. 32 **Site** 6

History

Initiated 1971

Excavation Method

Hydraulic

Material Utilization

Fill

Available Data

Physical

Alterations

NA

Description

Shape

Rectangular

Size

Diameter, m NA

Length, m 183

Width, m 121

Depth, m NA

Area, km^2 0.02

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Savannah, CE.

Table 110

Subaqueous Pit, Hole, or Depression Characteristics

Site 10, Vicinity of Sapelo Sound, Georgia

Location

Geographic Coordinates

North 31° 55' to 31° 59'

West 81° 09' to 81° 13'

CE District Savannah

State Georgia

County Chatham

C & G Chart 440, 1241

1:250,000 Topographic Map Brunswick, Georgia

Fig. 32 Site 10

History

Initiated 1967-68

Excavation Method

Hydraulic

Material Utilization

Fill

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 22860

Width, m 305

Depth, m NA

Area, km^2 6.96

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Savannah, CE.

Table 111

Subaqueous Pit, Hole, or Depression Characteristics

Site 11, Vicinity of Sapelo Sound, Georgia

Location

Geographic Coordinates

North 31° 39' 08"

West 81° 23' 00"

CE District Savannah

State Georgia

County Liberty

C & G Chart 1241

1:250,000 Topographic Map Brunswick, Georgia

Fig. 32 **Site** 11

History

Initiated 1968

Excavation Method

Hydraulic

Material Utilization

Fill

Available Data

NA

Alterations

NA

Description

Shape

Rectangular

Size

Diameter, m NA

Length, m 914

Width, m 960

Depth, m 8

Area, km^2 0.87

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.

Data Source: U. S. Army Engineer District, Savannah, CE.

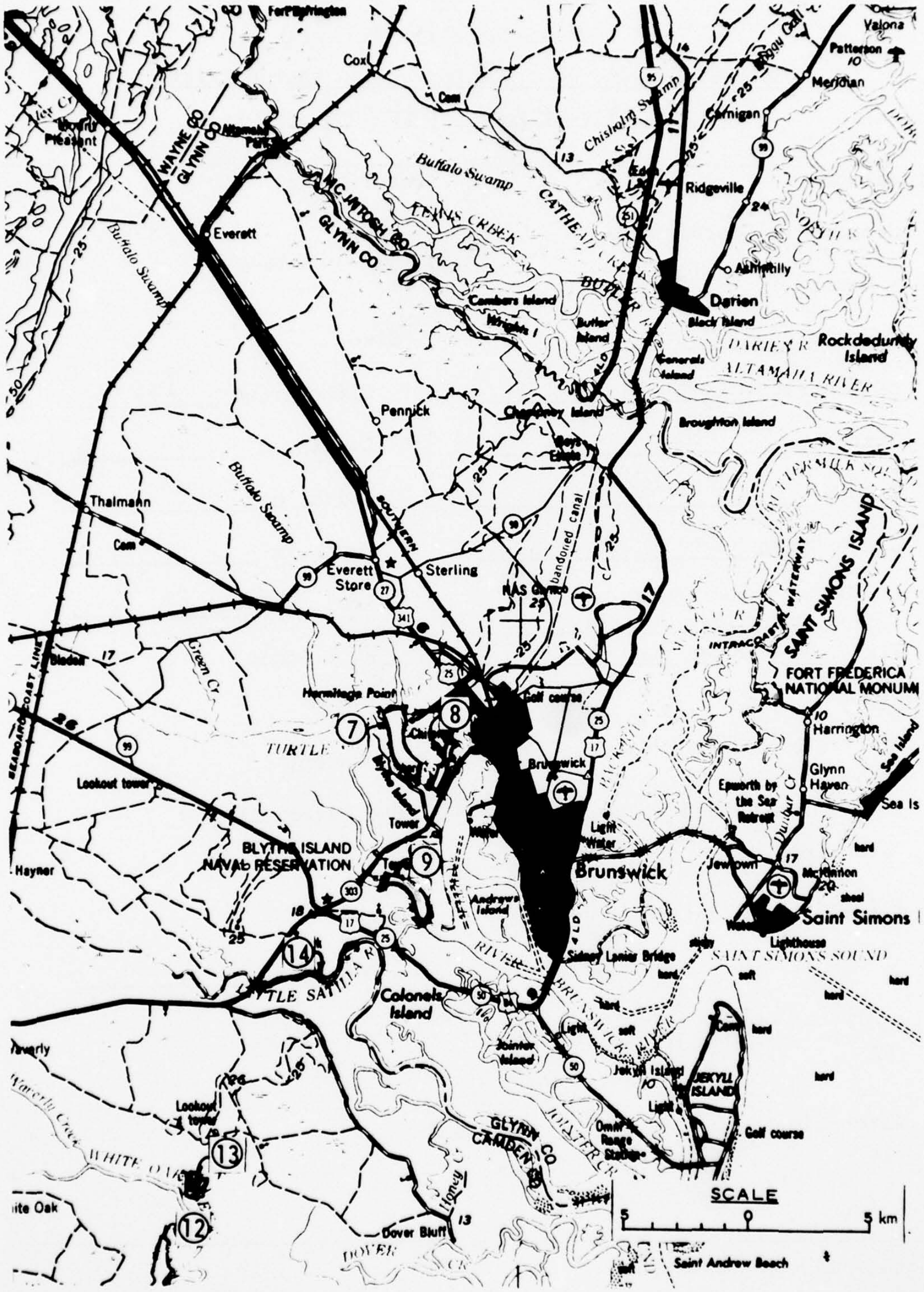


Figure 33. Subaqueous site locations, vicinity of Brunswick, Georgia

Table 112

Subaqueous Pit, Hole, or Depression Characteristics

Site 7, Vicinity of Brunswick, Georgia

Location

Geographic Coordinates

North 31° 12'

West 81° 33'

CE District Savannah

State Georgia

County Glynn

C & G Chart 447

1:250,000 Topographic Map Brunswick, Georgia

Fig. 33 **Site** 7

History

Initiated late 1972

Excavation Method

Hydraulic

Material Utilization

Fill

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 3180

Width, m 620

Depth, m NA

Area, km^2 1.93

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.

Data Source: U. S. Army Engineer District, Savannah, CE.

Table 113

Subaqueous Pit, Hole, or Depression Characteristics

Site 8, Vicinity of Brunswick, Georgia

Location

Geographic Coordinates

North 31° 11'

West 81° 32'

CE District Savannah

State Georgia

County Glynn

C & G Chart 447

1:250,000 Topographic Map Brunswick, Georgia

Fig. 33 Site 8

History

Initiated late 1972

Excavation Method

Hydraulic

Material Utilization

Fill

Available Data

NA

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m NA

Area, km^2 0.42

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.

Data Source: U. S. Army Engineer District, Savannah, CE.

Table 114

Subaqueous Pit, Hole, or Depression Characteristics

Site 9, Vicinity of Brunswick, Georgia

Location

Geographic Coordinates

North 31° 09'

West 81° 33'

CE District Savannah

State Georgia

County Glynn

C & G Chart 447

1:250,000 Topographic Map Brunswick, Georgia

Fig. 33 **Site** 9

History

Initiated late 1972

Excavation Method

Hydraulic

Material Utilization

Fill

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 2896

Width, m 457

Depth, m NA

Area, km^2 1.32

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Savannah, CE.

Table 115

Subaqueous Pit, Hole, or Depression Characteristics

Site 12, Vicinity of Brunswick, Georgia

Location

Geographic Coordinates

North 31° 00'

West 81° 39'

CE District Savannah

State Georgia

County Camden

C & G Chart 448

1:250,000 Topographic Map Brunswick, Georgia

Fig. 33 **Site** 12

History

Initiated 1972

Excavation Method

Hydraulic

Material Utilization

Fill

Available Data

Physical

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m 10-15

Area, km^2 1.33

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.

Data Source: U. S. Army Engineer District, Savannah, CE.

AD-A043 052 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 13/2
INVESTIGATION OF SUBAQUEOUS BORROW PITS AS POTENTIAL SITES FOR --ETC(U)
MAY 77 J D BROUGHTON

UNCLASSIFIED WES-TR-D-77-5 NL

3 OF 3
AD
A043052

END
DATE
FILMED
9-77
DDC

Table 116

Subaqueous Pit, Hole, or Depression Characteristics

Site 13, Vicinity of Brunswick, Georgia

Location

Geographic Coordinates

North 31° 02'

West 81° 38'

CE District Savannah

State Georgia

County Camden

C & G Chart 448

1:250,000 Topographic Map Brunswick, Georgia

Fig. 33 Site 13

History

Initiated 1972

Excavation Method

Hydraulic

Material Utilization

Fill

Available Data

NA

Alterations

NA

Description

Shape

Linear

Size

Diameter, m NA

Length, m 2134

Width, m 213

Depth, m NA

Area, km^2 0.45

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Savannah, CE.

Table 117

Subaqueous Pit, Hole, or Depression Characteristics

Site 14, Vicinity of Brunswick, Georgia

Location

Geographic Coordinates

North 31° 06' to 31° 08'

West 81° 33' to 81° 38'

CE District Savannah

State Georgia

County Glynn and Camden

C & G Chart 447

1:250,000 Topographic Map Brunswick, Georgia

Fig. 33 Site 14

History

NA

Excavation Method

NA

Material Utilization

Fill

Available Data

NA

Alterations

NA

Description

Shape

NA

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m NA

Area, km^2 NA

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Savannah, CE.

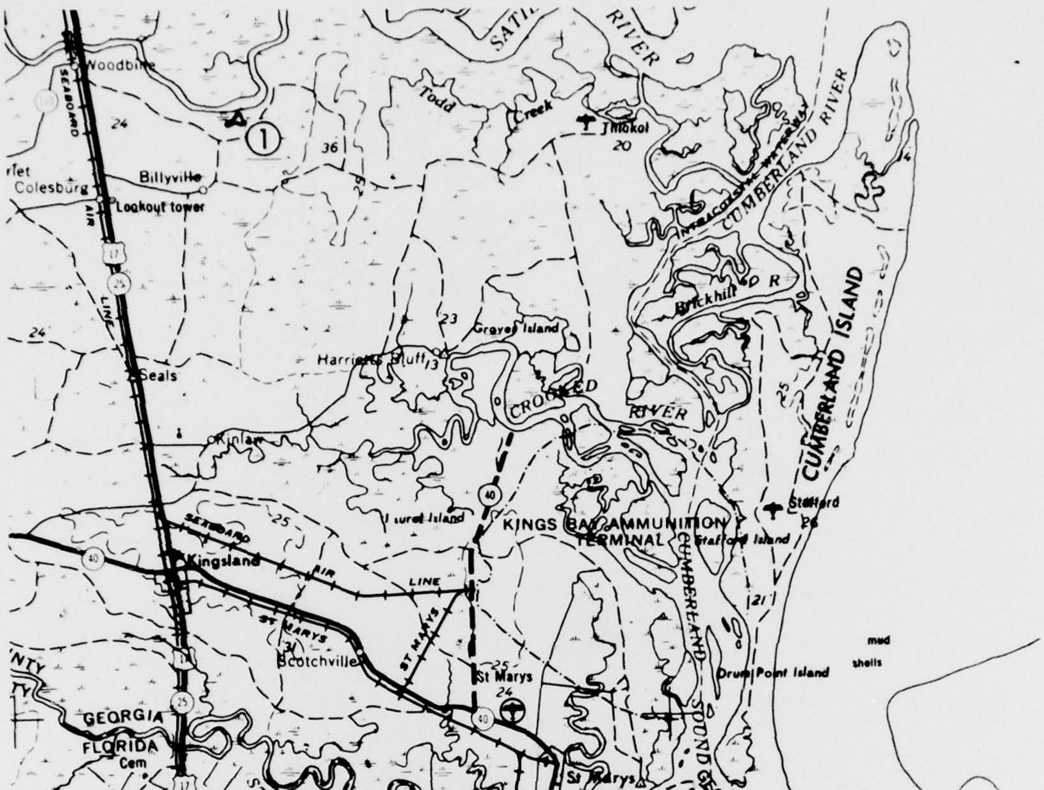


Figure 34. Subaqueous site location, vicinity of Satilla River, Georgia

Table 118

Subaqueous Pit, Hole, or Depression Characteristics

Site 1, Vicinity of Satilla River, Georgia

Location

Geographic Coordinates

North 30° 57'

West 81° 40'

CE District Savannah

State Georgia

County Camden

C & G Chart 448

1:250,000 Topographic Map Jacksonville, Florida

Fig. 34 **Site** 1

History

Initiated 1972

Excavation Method

Hydraulic

Material Utilization

Fill
147,000 cu yd

Available Data

NA

Alterations

NA

Description

Shape

Irregular

Size

Diameter, m NA

Length, m NA

Width, m NA

Depth, m NA

Area, km^2 0.12

Bank Angle

NA

Environment

Bed Materials

NA

Water

Depth, m NA

Note: NA = not available.
Data Source: U. S. Army Engineer District, Savannah, CE.

In accordance with ER 70-2-3, paragraph 6c(1)(b), dated 15 February 1973, a facsimile catalog card in Library of Congress format is reproduced below.

Broughton, Jerald D
Investigation of subaqueous borrow pits as potential sites for dredged material disposal, by Jerald D. Broughton. Vicksburg, U. S. Army Engineer Waterways Experiment Station, 1977.
1 v. (various pagings) illus. 27 cm. (U. S. Waterways Experiment Station. Technical report D-77-5)
Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C., under DMRP Work Unit 3A01.
Includes bibliography.

1. Dredged material disposal. 2. Sand and gravel dredging. 3. Shell dredging. 4. Subaqueous depressions. 5. Submarine canyons. I. U. S. Army. Corps of Engineers. (Series: U. S. Waterways Experiment Station, Vicksburg, Miss. Technical report D-77-5)
TA7.W34 no.D-77-5